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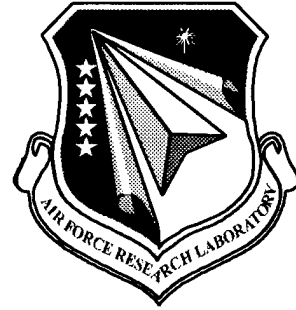
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CONSTRUCTION OF A PULSED STREAMER CORONA REACTOR

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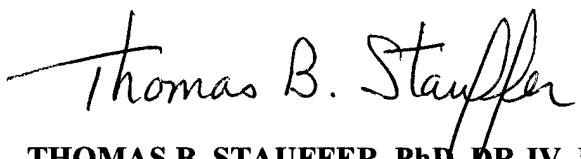
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REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.				
1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE 5 June 1995		3. REPORT TYPE AND DATES COVERED Final Report; June 1994 - June 1995
4. TITLE AND SUBTITLE Construction of a Pulsed Streamer Corona Reactor			5. FUNDING NUMBERS C - F08637-94-M-6015 PE - 0602202F JON - 1900A35B	
6. AUTHOR(S) Locke, Bruce R., PhD; Finney, Wright C.				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Department of Chemical Engineering FAMU/FSU College of Engineering 2525 Pottsdamer Street Tallahassee, FL 32316-2175			8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Air Force Research Laboratory Air Expeditionary Forces Technologies Division (AFRL/MLQ) 139 Barnes Drive, Suite 2 Tyndall AFB, FL 32403-5323			10. SPONSORING/MONITORING AGENCY REPORT NUMBER AFRL-ML-TY-TR-2000-4534	
11. SUPPLEMENTARY NOTES				
12a. DISTRIBUTION AVAILABILITY STATEMENT Approved for Public Release			12b. DISTRIBUTION CODE A	
13. ABSTRACT (Maximum 200 words) The objective of this effort was to construct a pulsed corona discharge capability for conducting investigations into the destruction of noxious combustion products from jet engines and ground support equipment. As the first step in the investigations, a pulsed corona discharge system consisting of a high-voltage AC power supply, a rotating spark gap and pulse-forming electronic components, and stainless steel pulsed corona reactor was built and commissioned. This report documents the design, construction, and operation of the reactor. Results of specific investigations into the effects of the pulsed corona reactor on various waste streams will be documented in separate reports.				
14. SUBJECT TERMS Pulsed corona; NOx; combustion products; exhaust; air pollution			15. NUMBER OF PAGES 149	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclass	18. SECURITY CLASSIFICATION OF THIS PAGE Unclass	19. SECURITY CLASSIFICATION OF ABSTRACT Unclass	20. LIMITATION OF ABSTRACT UL	

PREFACE

The work presented herein was conducted by the Department of Chemical Engineering at the FAMU/FSU College of Engineering, through United States Air Force contract F08637-94-M-6015 with The Florida State University.

We are very happy to acknowledge the assistance of Mr. David Grymonpre' for preparing the design drawing and Mr. Swaminathan Kalyana and Mr. Grymonpre' for assistance in assembling and testing the reactor and power supply. In addition, we would like to thank the Fabrication Shop of the Department of Physics at Florida State University for the welding and construction of the stainless steel reactor and mixing chambers, and the Mechanical Engineering Shop of the FAMU/FSU College of Engineering for fabrication of the Plexiglas parts for the rotating spark gap unit. The Department of Chemical Engineering of the FAMU/FSU College of Engineering provided additional assistance for laboratory space, miscellaneous materials and supplies, and salary support.

EXECUTIVE SUMMARY

The objective of this effort was to construct a pulsed corona discharge capability for conducting investigations into the destruction of noxious combustion products from jet engines and ground support equipment. As the first step in the investigations, a pulsed corona discharge system consisting of a high-voltage AC power supply, a rotating spark gap and pulse-forming electronic components, and stainless steel pulsed corona reactor was built and commissioned. This report documents the design, construction, and operation of the reactor. Results of specific investigations into the effects of the pulsed corona reactor on various waste streams will be documented in separate reports.

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I. INTRODUCTION

The purpose of this project was to design and build a laboratory-scale pulsed streamer corona generation apparatus and reactor to support the US Air Force's effort to investigate the feasibility of using this technology for removing nitrogen oxides from the combustion exhaust gases of jet engine testing facilities. This contract was performed by the Department of Chemical Engineering at the FAMU/FSU College of Engineering, through contract with The Florida State University by the United States Air Force. The major equipment items (fully described in Appendix I) were purchased by the United States Government (Tyndall AFB), and delivered to the job site (College of Engineering Building, 2525 Pottsdamer Street, Tallahassee, FL). Through a modification of the original contract the experimental apparatus was installed in a laboratory at the Department of Chemical Engineering at the FAMU/FSU College of Engineering in anticipation of future work to be performed with the power supply reactor at this site.

A pulsed streamer corona reactor utilizes a high-voltage electrical discharge produced within a non-uniform electrode geometry to initiate chemical reactions that lead to the removal of various pollutants from a gas stream. The physical aspects of a gas-phase discharge in a non-uniform electrical field include the formation of ionization waves (streamers) through the growth of electron avalanches formed by electron impact ionization events in the gas. The streamer is a region of highly ionized gas (a non-thermal plasma) where a wide range of highly reactive radicals and chemical species are formed through collisions among electrons, molecules and ions. In the case of NO_x removal, hydroxyl radicals created from water vapor lead to the eventual formation of nitric acid aerosols, that in turn could be removed by scrubbers, particle filtration devices, or electrostatic precipitators.

The essential features of a pulsed streamer corona reactor system include the high-voltage AC input power supply, the rotating spark gap and pulse-forming electronic components, and the stainless steel pulsed corona reactor. The power supply is a commercially available unit that was purchased by the US Air Force and delivered to the site. The pulse-forming unit consisting of a rotating spark gap and auxiliary electronic parts (described below) was fabricated on site using materials supplied by the US Air Force and parts purchased on this contract. The wire-to-

cylinder-geometry reactor, containing a high-voltage wire electrode suspended concentrically within a cylindrical stainless steel tube, was also fabricated at Florida State University with materials supplied by the US Air Force.

The reactor system was designed to run under ambient temperature and pressure conditions, with a gas residence time in the active region of the reactor of approximately 5 seconds at a flow rate of 1 ft³/min. The present contract did not include the development of a gas feed and mixing system for introducing nitrogen oxide and other gases to the reactor. Specification and construction of a gas feed system will be the subject of the next proposal for contract (refer to Section II.4, Future Work).

II. GENERAL SYSTEM DESCRIPTION

The pulsed streamer corona reactor system utilizes a high voltage-electrical discharge to initiate chemical reactions that lead to pollutant destruction and removal. The system includes as its major components the pulsed power supply and the corona reactor. Shown schematically in Figures 1 and 2, the apparatus utilizes a high-voltage AC 60-Hz input provided by a Universal Voltronics power supply. The input current flows through a bank of current-limiting resistors to protect the circuit in case of overload. A high-voltage rectifier serves to modify the AC current waveform by removing the lower half of the sine wave. A capacitor bank at the input to the mechanical rotating spark gap charges when the rotating arm is not aligned and discharges when the rotating spark gap is aligned. The characteristics of the capacitor bank determine the rise time for the pulsed waveform that is ultimately delivered to the reactor. A schematic of the pulsed waveform is shown in Figure 3. The pulse duration is on the order of 200 ns, while the pulse rise time is approximately 20 ns. The spark gap is aligned and synchronized with a strobe lamp. The unit constructed for this project is fundamentally similar to but further developed than units previously developed and patented at Florida State University (Clements, et al., 1989; Mizuno and Clements, 1987).

1. Power Supply

The high-voltage reversible-polarity power supply was purchased from Universal Voltronics (Model # BAL-130-28-T). The basic features and specifications of this power supply are shown in Table 1. The power supply can be configured in either an AC or DC mode of operation. For the purposes of this project, AC input voltage will be considered. This power supply allows for operation up to approximately 100 kV of AC or DC voltage.

2. Rotating Spark Gap

The rotating spark gap shown schematically in Figure 4, utilizes an 1800-rpm motor attached to a central axle equipped with a stainless steel perpendicular rod electrode and attached to bearings at the top and bottom. Two spherical stainless steel electrodes are aligned at opposite sides of the Plexiglas assembly and are attached to ceramic feedthrough devices. The housing of the rotating spark gap is made of ½-in. thick Plexiglas and detailed design drawings of the unit

are shown in Figures 5 through 16. The entire system is enclosed in an aluminum Faraday cage support structure that is grounded to minimize RF noise interference with external electronic devices. Figures 17 to 20 show detailed design drawings for the aluminum Faraday cage.

3. Corona Reactor

The main body of the pulsed corona reactor vessel is shown in Figures 21 to 23. The reactor spool section is constructed of a 4-in. diameter #316 stainless steel cylinder that is 18 inches long from end to end. The electrically active region of the reactor consists of a central 12-in. long section of the reactor, through which the stainless steel wire electrode runs down the center of the reactor body. This will provide a 5-second residence time in the active region of the reactor for a flow of 1 ft³/min. The linear gas velocity in the reactor under these conditions will be approximately 0.2 ft/sec for a Reynolds number of 450. These conditions are similar to other pulsed corona reactors reported in the literature (Creyghton, 1994).

A mixing chamber (Figure 25) was also constructed of 2-in. diameter stainless steel tubing. The inlet gas flow to the corona reactor will first flow through the mixing chamber to ensure that the feed and trace gases are well mixed prior to treatment by the pulsed streamer corona.

The wire electrode is connected to the high-voltage input through a 30-kV electrical feedthrough ceramic insulator. Figure 24 shows the connection points for the ceramic insulator, the reactor spool section, and the intermediate bushing. The ends of the reactor have been capped with #304 stainless steel flanges welded to the reactor body, and stainless steel end caps are bolted with eight bolts to each of the flanges (shown in Figure 25). The outer body of the reactor is grounded.

4. Future System Development and Experimental Plans

A network to feed gas to the reactor (shown in Figure 29) will be constructed during the next phase of the project pending approval of funding. This system will be capable of using air and/or nitrogen as the primary carrier gases as feed to the existing pulsed corona reactor. The feed system will also allow for the introduction of metered quantities of the following gases: 1)

oxygen, 2) water vapor, 3) NO, 4) NO₂, 5) CO₂, 6) CO, and 7) hexane. The capability of thoroughly mixing these gases will be included.

The experimental plans for this upcoming work include running the gas-phase pulsed corona reactor under a variety of gas feed conditions to investigate the effect of pulsed voltage level on the removal of NO_x and the formation of reaction products. Preliminary studies with air as the carrier gas will be performed to test the power supply, rotating spark gap, reactor, and analytical instruments. Other studies will use N₂ as the carrier gas and NO as the only gas contaminant. These studies will be run at various voltage levels and NO concentrations to determine the initiation rate constants for the dissociation of N₂ by the pulsed corona. Thereafter, studies will be performed with the addition to the feed gas of: 1) oxygen, 2) water vapor, 3) NO₂, 4) CO₂, 5) CO, and 6) hexane. A feed gas screening matrix will be developed to evaluate the destruction of NO and NO₂ in the presence of additional gases and vapors listed in the proposal. Particular emphasis will be placed on determining the effects of hydrocarbons (primarily hexane) on the removal rates of NO_x and identification of byproducts formed by these hydrocarbons. Removal rates as functions of the inlet concentrations and gas reactor flow rates will be determined using an NO_x analyzer, an ozone monitor and a gas chromatograph. Identification of unknown byproducts will be performed using GC/MS. The reactor temperature will be maintained at ambient conditions. The pulsed corona discharge characteristics will be measured using a previously purchased Tektronics digital storage oscilloscope incorporating a high-voltage probe and a current-measuring device.

Mathematical modeling of the pulsed corona reactor will include initial evaluation of the chemical kinetics of NO removal using literature information on the reaction rate constants. Conditions for these modeling efforts will include using a nitrogen atmosphere while varying the corona-induced reactions. A computer code (CHEMKIN) available from U.S. Government National Laboratories is being adapted to perform the chemical kinetics simulations. Commercially available software for analyzing the plasma chemistry of the pulsed corona discharge through solution of the Boltzmann equation for the electron velocity distribution function can be applied. These programs (ELINDIF and KINEMA) are the standard programs commonly used for approximation of the Boltzmann equations, and are the programs

recommended by researchers at the National Laboratories. This will involve the use of the Boltzmann codes to determine the corona-initiated reaction rate constants that will in turn be used to model the reactions of the chemical species. The results of these computations can be directly compared to the experimental results. This will allow for the determination of the major pathways for NO_x destruction and an optimization of the reactor operation for highly efficient NO_x removal.

III. PULSED POWER GENERATION AND REACTOR OPERATION

1. Commissioning of the Power Generation Apparatus

The "pulsed power supply" is composed of several components that serve to produce the desired pulsed voltage for the reactor. The original design specifications for the pulsed power output are as follows: pulse width (or duration) $a = 100 - 500$ ns, pulse rise time $= 20 - 50$ ns, pulse frequency $= 60$ Hz, pulse voltage range $= 20 - 80$ kV peak. For all experimental conditions, these parameters will be directly measured using a digital storage oscilloscope mated to a high-voltage probe and a sophisticated amplified current measuring system.

In circuit order, from voltage inception at the building AC service to delivery at the discharge electrode, the first component of the power generating apparatus is a Universal Voltronics reversible-polarity high-voltage DC power supply (converted to AC operation), consisting of 1) an HV transformer/rectifier (T-R) section immersed in an 85-gallon tank of insulating oil; 2) a control unit including variacs for coarse and fine voltage control, voltage output and current meters, indicator lamps and safety interlocks; 3) an interconnecting control cable between the T-R section and the control section; and 4) a high-voltage coaxial cable connected to the T-R section, providing high voltage at the termination.

Upon delivery, the Universal Voltronics DC power supply was conditioned or "broken in" according to manufacturer's recommendations. This was accomplished by periodically raising the voltage in 10-kV steps from 40% of rated output to 100% of rated output (130 kV maximum) over a period of approximately 24 hours. This break-in was done at a "no-load" condition, with the high-voltage cable being terminated by a 2-inch diameter corona sphere and also being electrically isolated. The complete break-in procedure is detailed in Section H of the Universal Voltronics power supply manual (Appendix II).

Disassembly and rewiring of the Universal Voltronics power supply was required for conversion to AC operation. After normal DC break-in, the transformer-rectifier section was lifted from the 85-gallon housing tank in order to rewire it for AC high-voltage output. Even though the Universal Voltronics power supply is shipped as a DC voltage output unit it can be easily rewired to produce AC voltage, which is needed for input to the pulse-forming network.

Additionally, the ability to return the supply to its original DC wiring configuration will allow maximum flexibility for possible later use of this same supply in a DC input pulse-forming network. Rewiring for AC operation is accomplished by disconnecting the internal high-voltage rectifier from the transformer, shunting the transformer primary to the HV output cable, and grounding the diodes, capacitors, and all other components as shown in Figure 31. After rewiring, the T-R section was returned to the oil tank and reconnected to the control section. The output from the reconfigured supply is now approximately 0 – 100 kV AC.

As shown in the circuit diagram (Figure 1), the high-voltage output is next delivered to the pulse-forming network that is housed in a large Faraday cage to shield other electronic components from spurious electromagnetic emissions. In order, AC input voltage passes first through a series of current-limiting resistors (333 kohm, 100 watt power capability). Next is a chain of diodes, which rectifies the voltage by removing the negative component of the AC voltage wave. The half-wave rectified voltage (positive polarity) is next sent to a set of doorknob high-voltage charge storage capacitors (4700-pF capacitance, 100 watt power capability), that are also connected to ground. Each of the above components is immersed in separate tanks of insulating oil and is interconnected by high-voltage wire.

From the capacitor bank, stored charge is delivered to a rotating spark gap apparatus, composed of an 1800-rpm motor connected to a rotating vertical shaft with a conductive horizontal crossbar situated halfway down the shaft. This crossbar repetitively swings in close proximity to an opposing set of 1-inch diameter stainless steel ball electrodes connected to the input and output of the spark gap. When the crossbar is aligned with the two ball electrodes, the gap is "closed" and a controlled short-duration voltage pulse (originating as stored charge in the capacitor bank) is allowed to pass. At all other times, no voltage passes through the gap. For example, for the present circuit, voltage passes across the gap for a total of only 10 – 20 microseconds during each second of operation.

From the output of the rotating spark gap, pulsed voltage is delivered to two circuits. The first is a series of "tail" resistors, which provides the pulsed voltage with a relatively low-resistance (tunable to between 50 and 400 ohms) pathway to ground that allows the spark gap to

fire since the resistance of the air gap between the electrodes in the reactor is very high (hundreds of megohms). The second pathway is directly to the reactor via an insulated high-voltage cable. Two airtight high-voltage feedthrough ceramic insulators atop the reactor spool section lead to a central wire electrode (0.109 inch diameter) suspended concentrically within the cylindrical outer reactor housing. When pulsed voltage is applied to the reactor, a radially symmetric electric field is maintained between the wire at high positive potential and the outer housing at ground potential. All of the system components requiring a ground are interconnected to a true earth ground network, composed of 6-inch-wide copper sheath running from each component to a 1-in. diameter grounding rod driven into the earth to a depth of 30 ft.

2. General Operation of the Power Generation Apparatus and Pulsed Corona Reactor

The operation of the experimental apparatus can be broken down into several major categories, performed in this order: a) preparatory and safety checkout of the various electrical and mechanical systems; b) startup and alignment of the rotating spark gap portion of the power generation apparatus; c) energizing the Universal Voltronics converted AC output power supply; d) monitoring of all of the operating parameters, including power supply voltage setting, and reactor pulsed voltage, current, and gas flow levels; and e) shutdown and safety checkout procedures. These are detailed stepwise in the following listing of specific operating procedures.

3. Specific Operating Procedures of the Power Generation Apparatus and Reactor

Preparatory Checkout:

1. Check all wiring within and between power generating apparatus and reactor.
2. Check ground sheathing, interconnecting cable, and high-voltage cable for the power supply.
3. Turn on exhaust hood to vent all ozone and other gases produced in the reactor system.

Spark Gap Alignment:

1. Open Plexiglas cover of shaft chamber of rotating spark gap; inspect ball electrodes and rotating rod electrode for any sign of oxidation or corrosion; sand

with fine grit sandpaper and clean with ethanol as required; replace spark gap cover.

2. Turn on stroboscope, rotating spark gap motor, and cooling fans.
3. Switch stroboscope to synchronize with AC line voltage (60.0 Hz = approx. 1800 rpm).
4. Observe "frozen" position of spark gap rotating bar; turn motor off and on as needed to align bar at a **right angle** to a position lined up with the two ball electrodes; turn off stroboscope.
5. Close doors to Faraday cage; secure with wedge.

Energizing the AC Power Supply:

1. Plug power supply control section into 208-VAC outlet.
2. Turn down coarse variac and vernier variac to zero.
3. Set front panel switches as follows: kV range to desired range (usually 0 – 130kV); polarity to "positive"; mA range to desired range.
4. Engage "Main" circuit breaker.
5. Engage "Control" circuit breaker.
6. Engage "Primary" circuit breaker.
7. Press "Overload Protect" button on.
8. Press "HV Off/Reset" button on.
9. Press "HV On" button on.
10. Raise coarse variac to desired setting on the dial (usually between 20 and 70 kV).
11. Adjust vernier variac for fine control of voltage output.

Monitoring of Voltage, Current, and Air Flow at the Reactor:

1. Using a Keithley high-voltage probe and a portable multimeter, monitor average peak voltage supplied to the reactor by touching probe to conductor at top of ceramic insulator.

2. Using the DC current meter connected between the reactor and ground, continuously monitor the average peak current (usually 0 – 20 mA) flowing between the center high-voltage electrode and the outer reactor housing.
3. Readjust the voltage output at the power supply control section as necessary.
4. If gas is flowing through the mixing section and reactor during a test, adjust and monitor input flow as required using a needle valve and a rotameter, respectively, connected to the compressed air source.

Shutdown of Reactor and Power Generating Apparatus:

1. Lower both variacs to zero.
2. Press "HV Off/Reset" button.
3. Disengage "Primary" circuit breaker.
4. Disengage "Control" circuit breaker.
5. Disengage "Main" circuit breaker.
6. Unplug power supply control unit.
7. Turn off air supply, if used.
8. Using grounding rod (composed of a long rod conductor that is both embedded in an electrically insulated handle and connected to earth ground by a braided copper cable), ground out by direct contact the following conductive terminations: reactor ceramic feedthrough; both input and output of rotating spark gap; capacitor bank; end of high voltage-power supply cable.

4. Condensed Operating Procedures of the Oscilloscope

Initiation of Oscilloscope Operation:

1. Check that the rear panel principal power switch is on.
2. Press "On/Stby" button.
3. Connect probe to one of the BNC connectors representing each of four channels.
4. To reset the digitizing oscilloscope, press the "Save/Recall Setup" button to display the setup menu. The main menu is displayed along the bottom of the screen.

5. Press the button directly below the "Recall Factory Setup" menu item. The display shows the side menus along the right side of the screen. The buttons to select these side menu items are to the right of the side menu.
6. Press the button to the right of "OK Confirm Factory Init" in the side menu.
7. Connect the probe to the Channel 1 BNC connector on the front panel. The oscilloscope is now ready to measure various parameters.
8. To get a stable waveform, press "Autoset."

In case one needs to view two waveforms at the same time, multiple channels are used. Two or more probes are connected to different channels via front panel BNC connectors, and the corresponding channel buttons are pressed.

The position of the waveforms can be shifted using the "Vertical Position" knob.

Pressing the "Waveform Off" button removes the waveform of the currently selected channel.

Reading Automated Measurements:

1. Press "Measure" button.
2. Press "Select Measrmnt" button in the main menu.
3. Press the button on the side menu corresponding to the measurement that you want to make.
4. To move the measurement outside the graticule press "Clear Menu."
5. To get a display of all the measurements that can be made on the waveform, press "Snapshot."

Saving Oscilloscope Measurements:

1. Press "Setup" button.
2. In the main menu press "Save Current Setup."
3. Saving can be done in "User," which overwrites the user setup previously stored, or in "Factory," which will not disturb the previously stored setups.

4. For removing Measurements press "Measure" followed by "Remove Measrmnt" in the main menu and "Measurement 1," etc., in the side menu.

5. Corona Laboratory Safety Procedures

Obviously when dealing with high voltage of any kind safety for personnel and sensitive equipment becomes of paramount importance. Several old saws concerning personal behavior around high voltage certainly apply here, namely, keeping as far away from the HV source as possible and keeping one's hands in one's pockets. Although the current output of the power generating apparatus is relatively small, being limited by the 28 mA maximum output of the Universal Voltronics power supply, the total power output of the system at 3.6 kW should be cause for concern. Awareness of proper operating methods will insure the safety of both people and equipment.

A great deal of attention has been devoted to installing an extensive grounding network, not only for the dissipation of the high-frequency pulsed voltage, but also for the safety of the operators. The grounding network is composed of essentially zero-resistance copper sheathing, and termination of the network is at true earth ground. A portable grounding rod connected by a flexible cable to this network is kept readily at hand near the power supply control section for the immediate use of the operators in the event of a malfunction or accident. This grounding rod can be utilized for shunting to ground any or all parts of the power generation circuit with no damage to the circuitry. At the conclusion of each experiment, a thorough shutdown and grounding regimen (detailed previously) takes place, which precludes any personnel from coming into contact with high voltage.

A large Faraday cage containing the pulse-forming network has been constructed to shield ancillary electronic equipment in the area from electromagnetic radiation produced by the spark gap. Additionally, this tightly constructed chamber protects personnel from coming in contact with these components, which float at high voltage when reactor is energized. All HV cables (themselves adequately shielded) are further at least double-sheathed by insulating tubing or conduit. The Universal Voltronics power supply has a number of safety features including automatic shunting of the high voltage to ground when an over voltage or over current situation

exists. Other safety procedures instituted by this research group include never operating the power generating apparatus or reactor without two operators present, and double-checking all connections and components thoroughly.

The pulsed corona reactor is a copious source of ozone production, and for this reason the entire reactor assembly has been placed within a laboratory hood. This allows for constant evacuation of gases produced in the reactor, thus preventing buildup of these gases in the laboratory. A vent will also be placed in the Faraday cage that contains the rotating spark gap to allow purging of gases produced within the spark gap. For further reactor testing under the next phase of the project, a scrubber will be installed to clean up all waste gases.

IV. REFERENCES

Clements, J.S., A. Mizuno, W.C. Finney, and R.H. Davis, Combined Removal of SO₂, NO_x, and Fly Ash from Simulated Flue Gas Using Pulsed Streamer Corona, IEEE Transactions on Industry Applications, 25(1) 1989, 62-69.

Creyghton, Y.L.M., Pulsed Positive Corona Discharges Fundamental Study and Application to Flue Gas Treatment, CIP Data Koninklijke Bibliotheek, Den Haag, 1994.

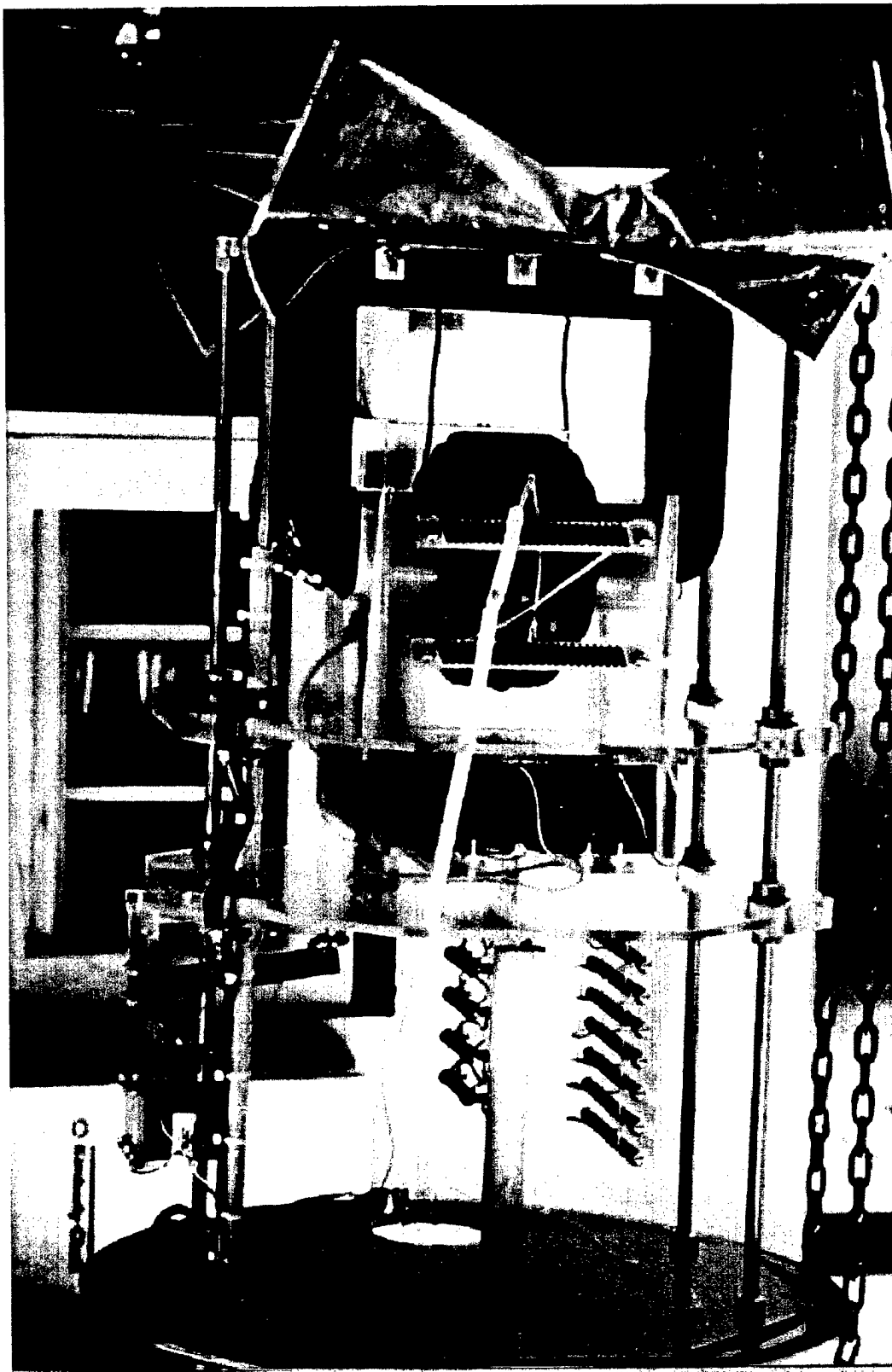
Masuda, S. and H Nakao, Control of NO_x by Positive and Negative Pulsed Corona Discharges, IEEE Transactions on Industry Applications, 26(2) 1990, 374-383.

Mizuno, A. and L.S. Clements, Method of Removing SO₂, NO_x, and Particles from Gas Mixtures Using Streamer Corona, United States Patent 4,695,358, September 22, 1987.

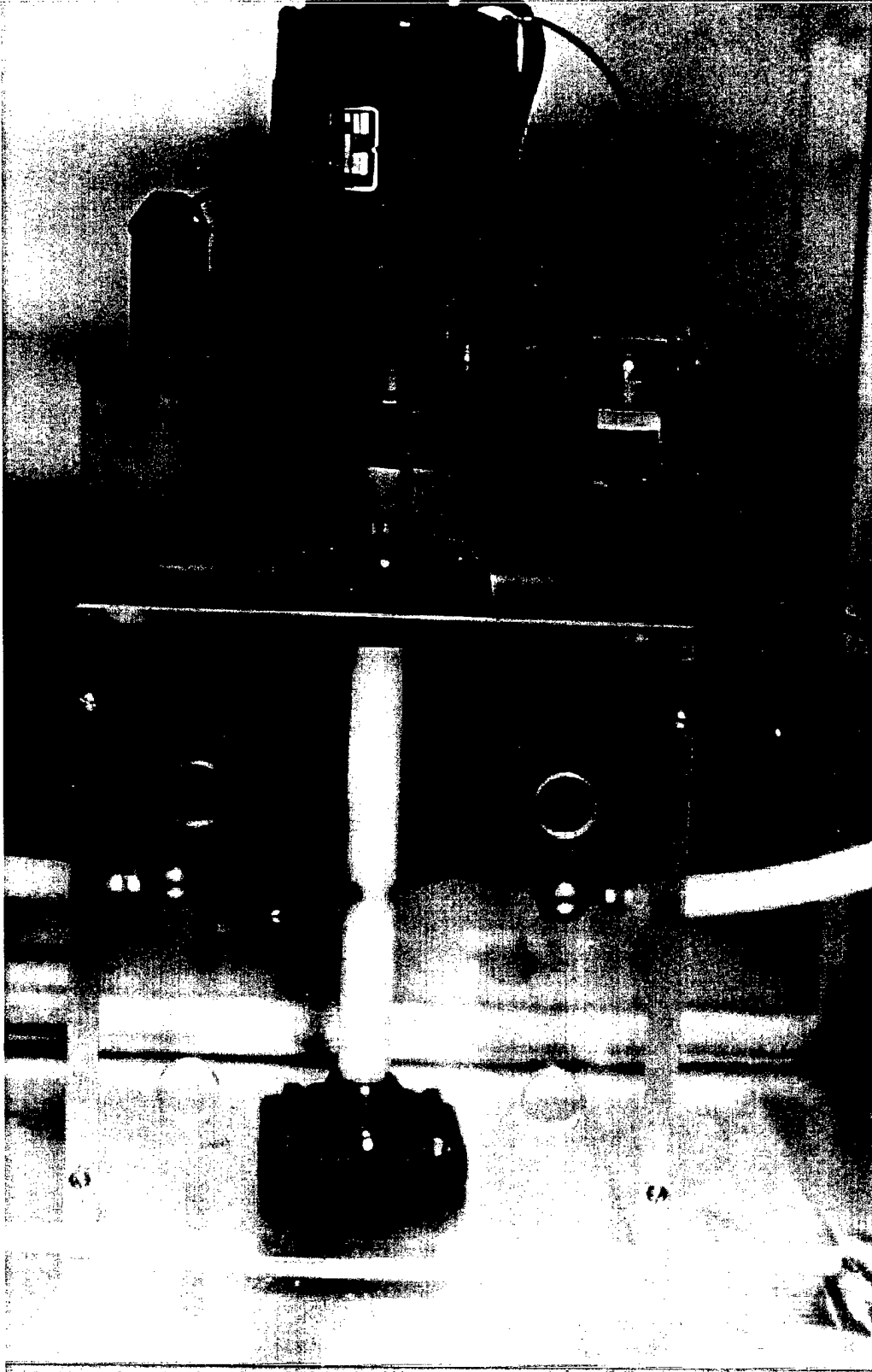
TABLE 1. Characteristics of the Universal Voltronics DC/AC High Voltage Power Supply
UVC Model: BAL-130-28-T

- I.0 Input Voltage: 208/230 Volts, 60Hz., 1 phase, 5KVA
approx. WYE Source required.
- 2.0 Output Voltage: 0-130 Kilovolts DC.
- 3.0 Output Current: 28 Milliamperes DC.
- 4.0 Polarity: Reversible
- 5.0 Ripple: 2% rms at 130KVDC and 28MADC
- 6.0 Regulation: Load: 20% from no load to full load of
28MADC at 130KVDC.
- 7.0 Regulation: Line: OUTPUT VARIES DIRECTLY WITH LINE
- 8.0 Environmental Specification: (Design intent):
 - 8.1 Ambient temperature operating 35°C.
Ambient temperature storage 60°C.
 - 8.2 Humidity: 100%
 - 8.3 Shock and vibration: Normal transcontinental shipment
 - 8.4 Life expectancy: 10,000 hrs. (estimated)
 - 8.5 Altitude: 2500 ft.
- 9.0 Mechanical: The equipment is built in two assemblies:
 - 9.1 Control Assembly
 - 9.1.1 Size: 22" W x 15" D x 16 ½" H, approx.
 - 9.1.2 Weight: 75 lbs. approx.
 - 9.1.3 Color: UVC Gray, High Gloss
 - 9.2 High Voltage Assembly:
 - 9.2.1 Size: 24" O.D. x 36" H.
 - 9.2.2 Weight: 250 less oil
 - 9.2.3 Weight: 650 with 50 gals. oil
 - 9.2.4 Color: UVC Gray, High Gloss
- 10.0 Meters:
 - 10.1 Output Kilovoltmeter: 0-15/60/150 KVDC,
±3% FS, 4-1/2" bakelite, meter relay
 - 10.2 Output Milliammeter: 0-3/10/30 Milliamperes
DC, ±3% FS, 4-1/2" bakelite, meter relay.
- 11.0 Safety and Protective Features:

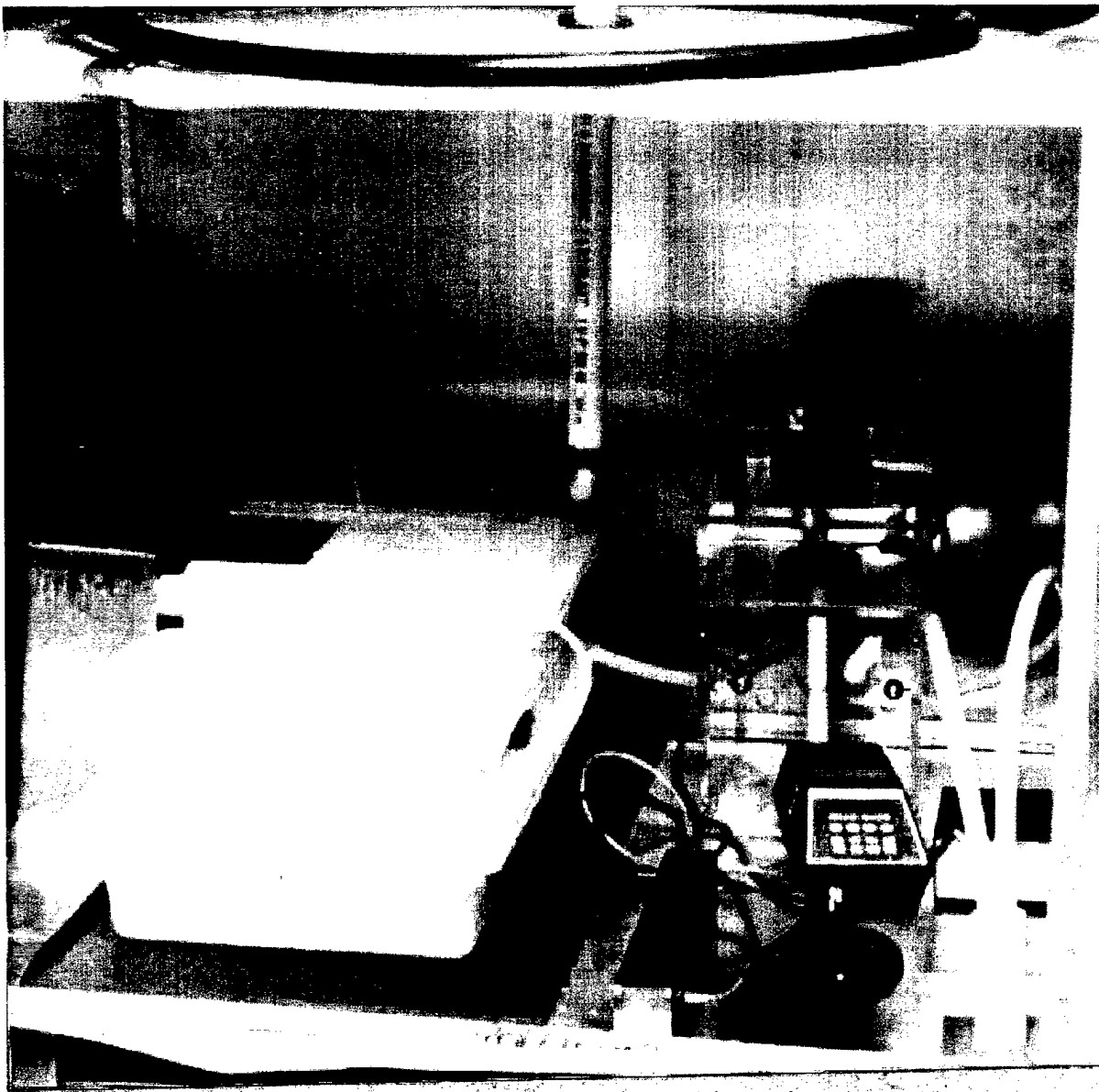
- 11.1 Main Circuit Breaker
 - 11.2 Control Circuit Breaker
 - 11.3 Primary Circuit Breaker
 - 11.4 Overload Adjust (integral with milliammeter 100 m-sec. response, approx.)
 - 11.5 Overvoltage Adjust (integral with Kilovoltmeter)
 - 11.6 External Interlock
 - 11.7 Zero Start Interlock
 - 11.8 Shorting Solenoid
- 12.0 Controls:
- 12.1 High Voltage Off, Reset Pushbutton
 - 12.2 High Voltage On Pushbutton
 - 12.3 Coarse Voltage Control
 - 12.4 Polarity (meter selector switch only)
 - 12.5 Vernier Voltage Control
 - 12.6 Milliammeter meter range selector switch (3 range)
 - 12.7 Surge On (Bypass pushbutton)
 - 12.8 Kilovoltmeter meter range selector switch (3 range)
 - 12.9 Overload Bypass pushbutton
- 13.0 Indicator Lights: (NEON except where otherwise indicated):
- 13.1 Main CB Open
 - 13.2 Control CB Open
 - 13.3 Interlock Open
 - 13.4 HV Access Open
 - 13.5 Set Controls to Zero
 - 13.6 Primary CB Open
 - 13.7 Overvoltage (incandescent - blue)
 - 13.8 Overload (incandescent - yellow)
 - 13.9 High Voltage Ready (incandescent - green)
 - 13.10 High Voltage On (incandescent - red)
- 14.0 Connections:
- 14.1 Input: 3 position terminal board, one position ground
 - 14.2 Output Cable: RG 8/U 15FT
 - 14.3 Ground: Threaded stud, on chassis rear.
 - 14.4 External Interlock: Two position terminal board on chassis rear.
 - 14.5 H.V. Access Interlock (on lucite rear panel)
 - 14.6 Interconnecting cable: 20FT



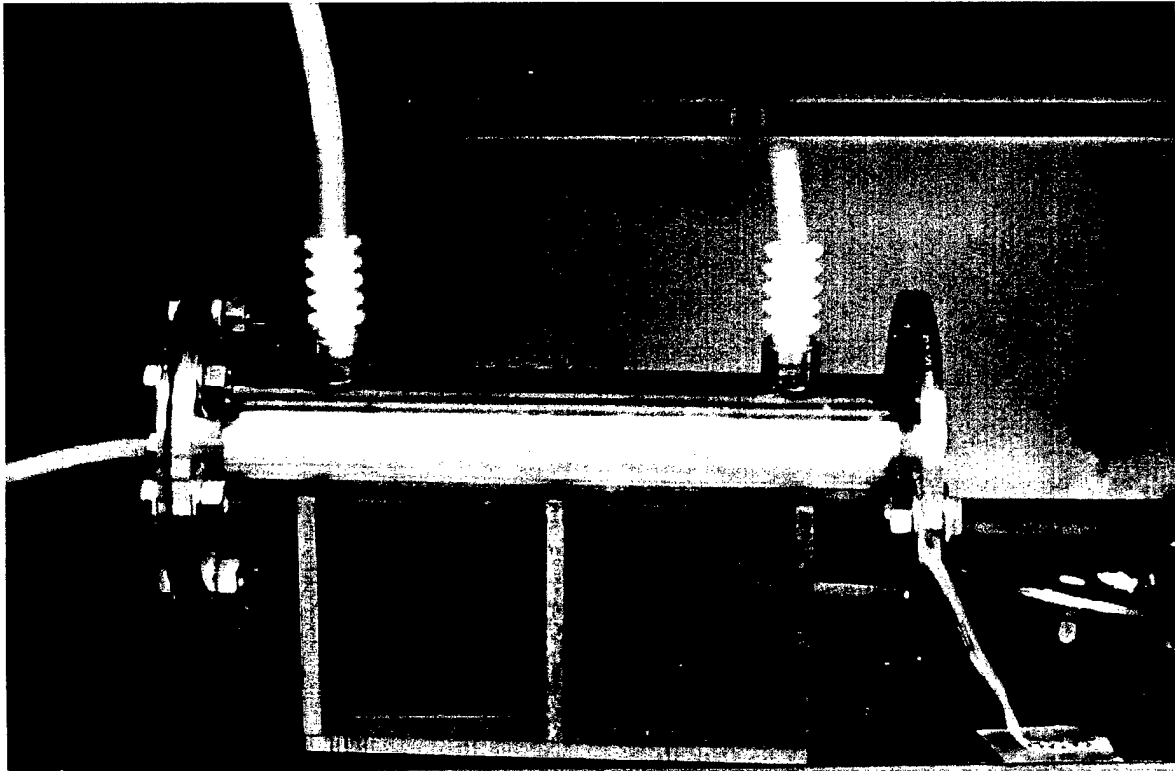
Photograph 1. Internals of Universal Voltronics Power Supply



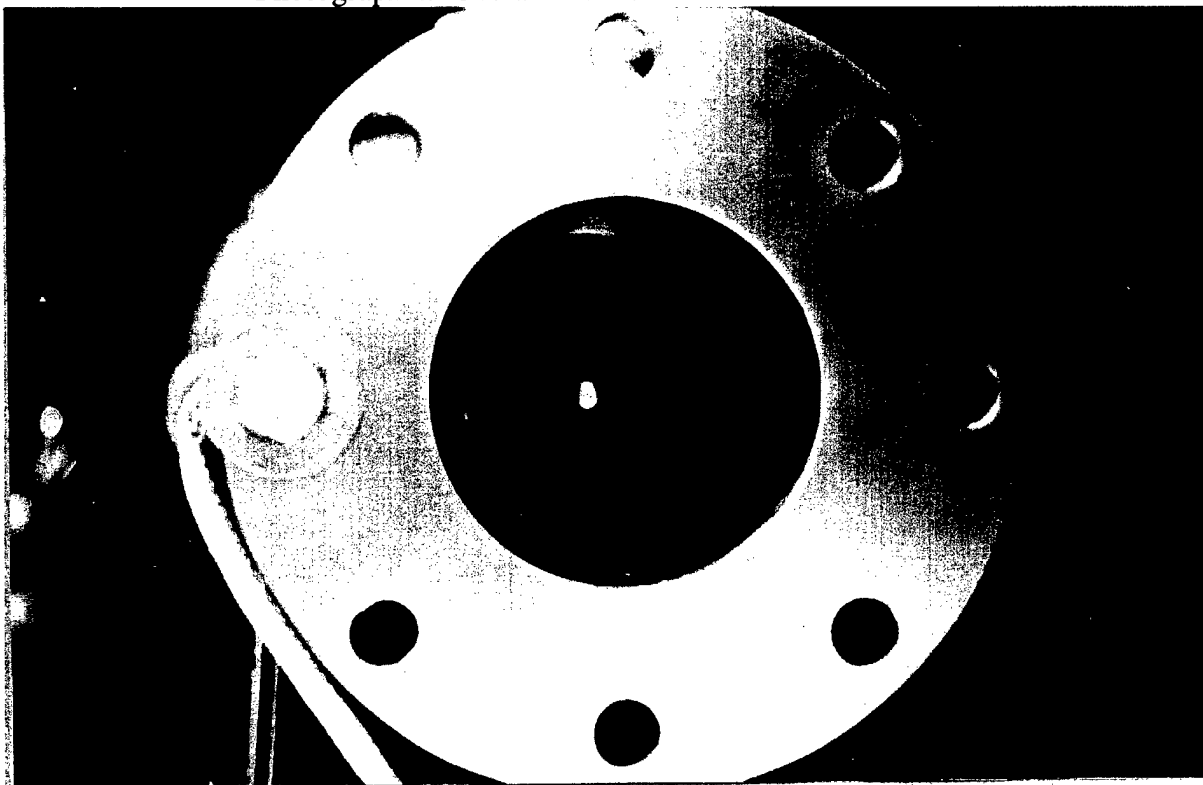
Photograph 2. Close-up of Rotating Spark Gap



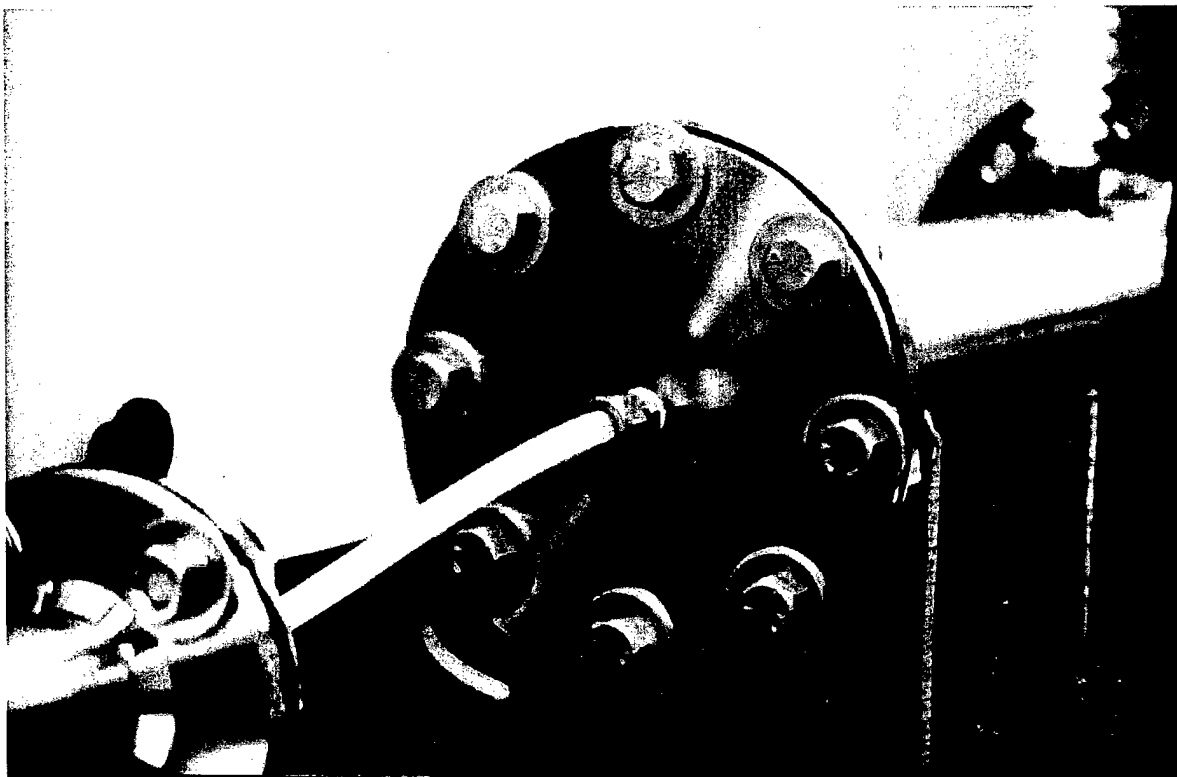
Photograph 3. Overall View of Faraday Cage with Spark Gap and Electronic Parts



Photograph 4. Overall View of Pulsed Corona Reactor



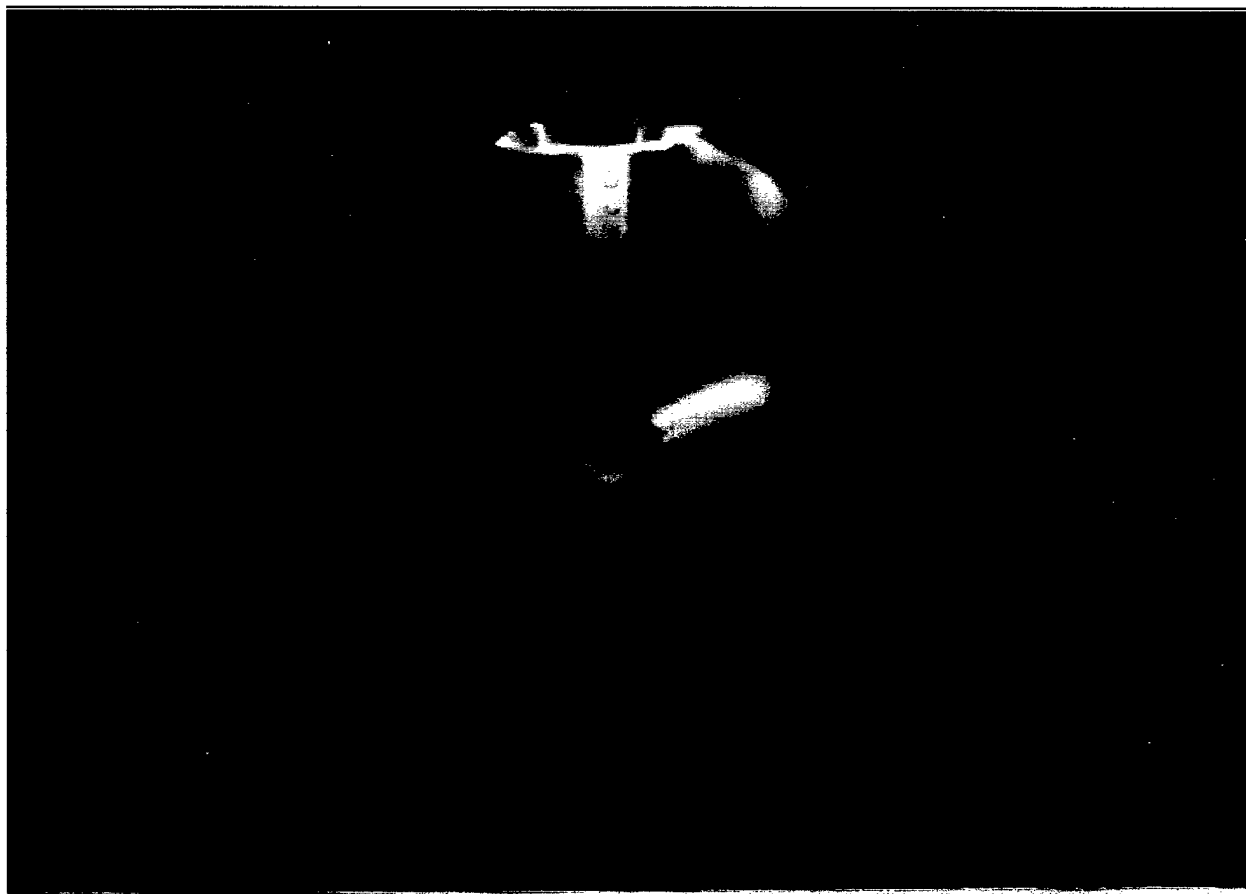
Photograph 5. Close-up of Interior of Pulsed Corona Reactor Showing Central Electrode



Photograph 6. View of Flanged Entrance to Reactor from Mixing Chamber



Photograph 7 Spark Gap in Operation



Photograph 8. End View of Reactor in Operation

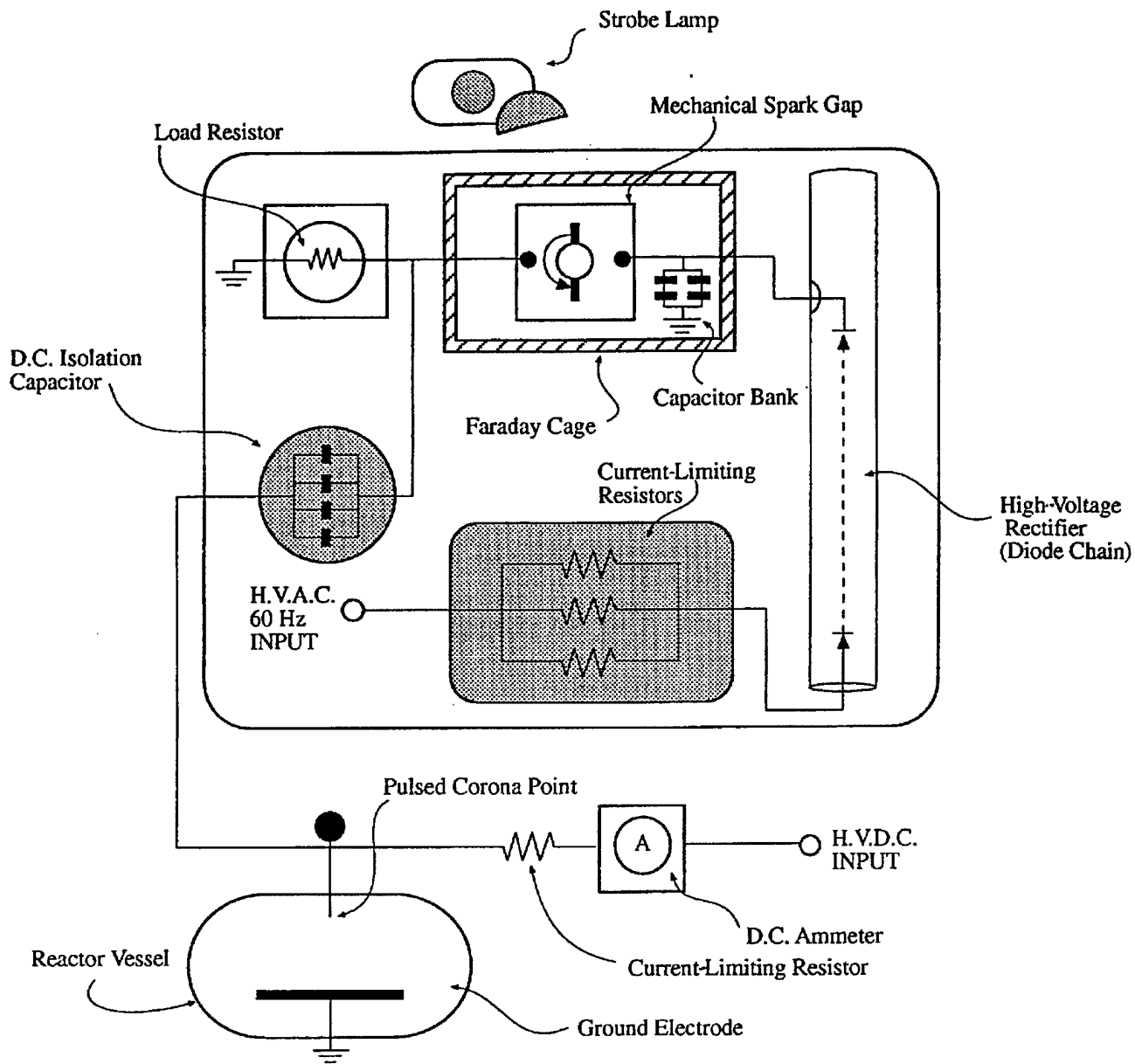


Figure 1. Pulsed Power Supply Schematic

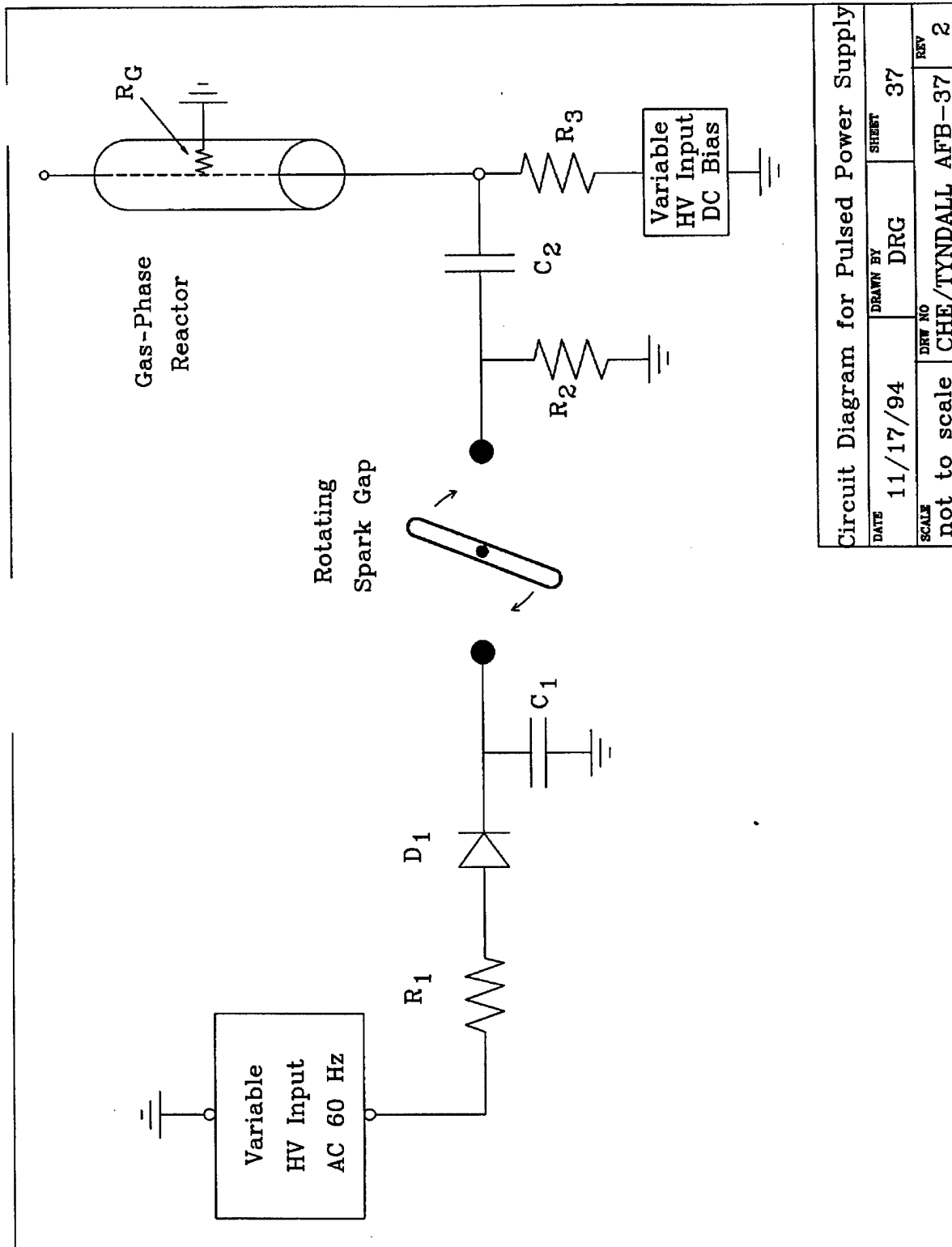
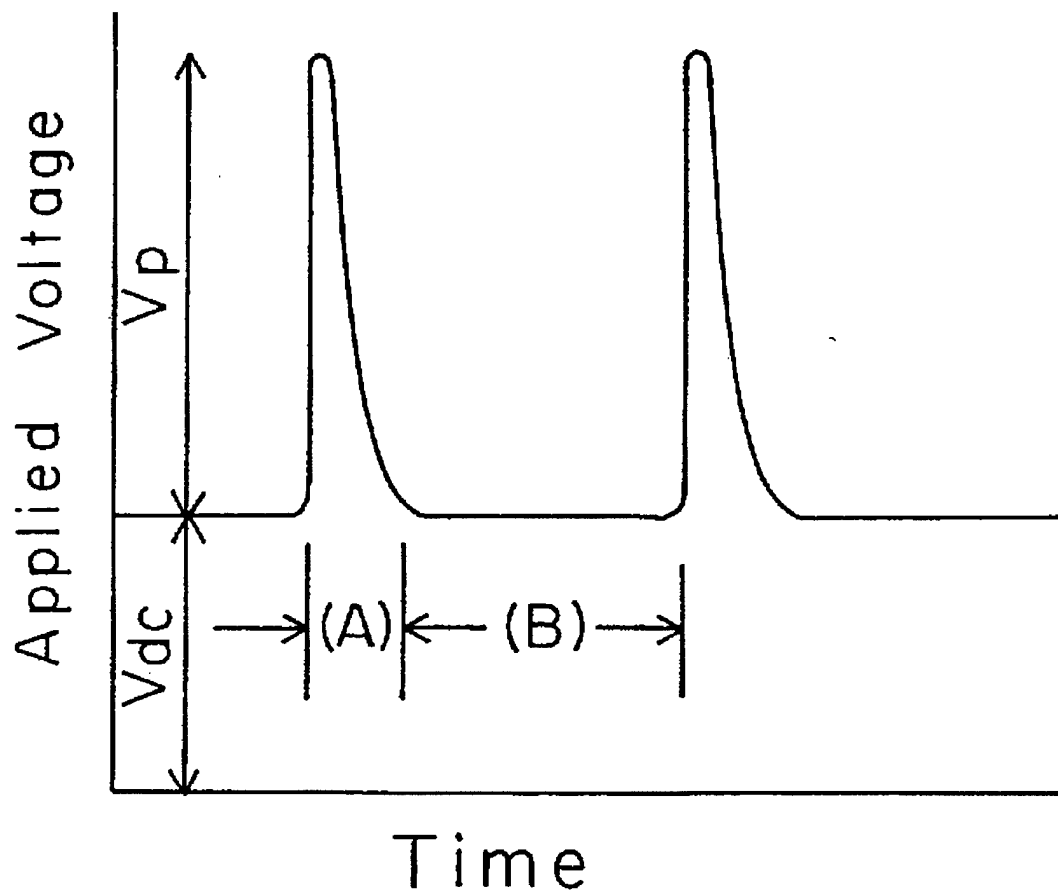


Figure 2. Circuit Diagram for Pulsed Power Supply



PEER Applied Voltage Waveform for the Combined Treatment Mode:

(A) = Pulse-On Period
(B) = Pulse-Off Period
 V_p = Peak Pulse Voltage
 V_{dc} = DC-Bias Voltage

Figure 3. Pulsed Waveform Schematic

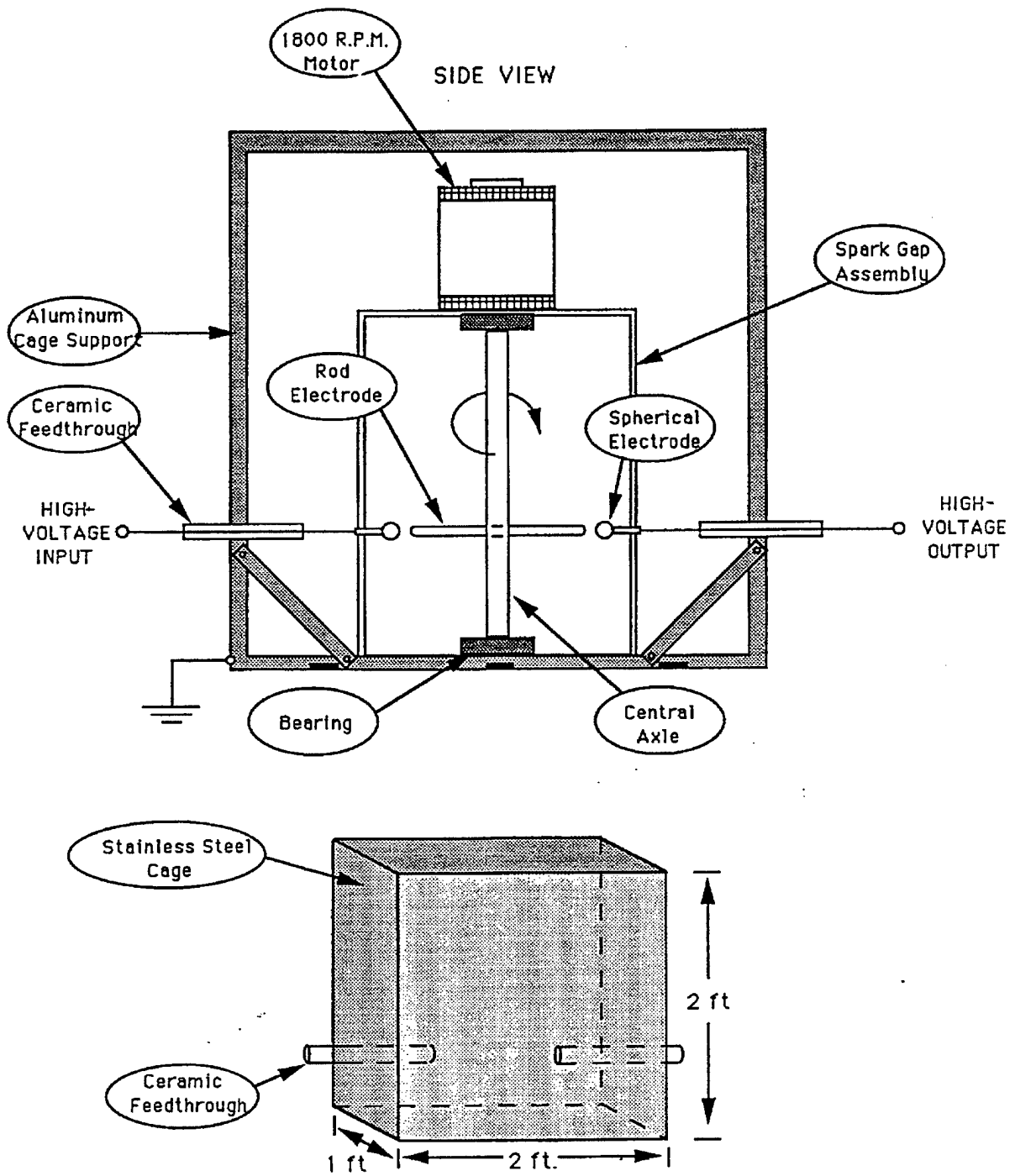


Figure 4. Rotating Spark Gap Schematic

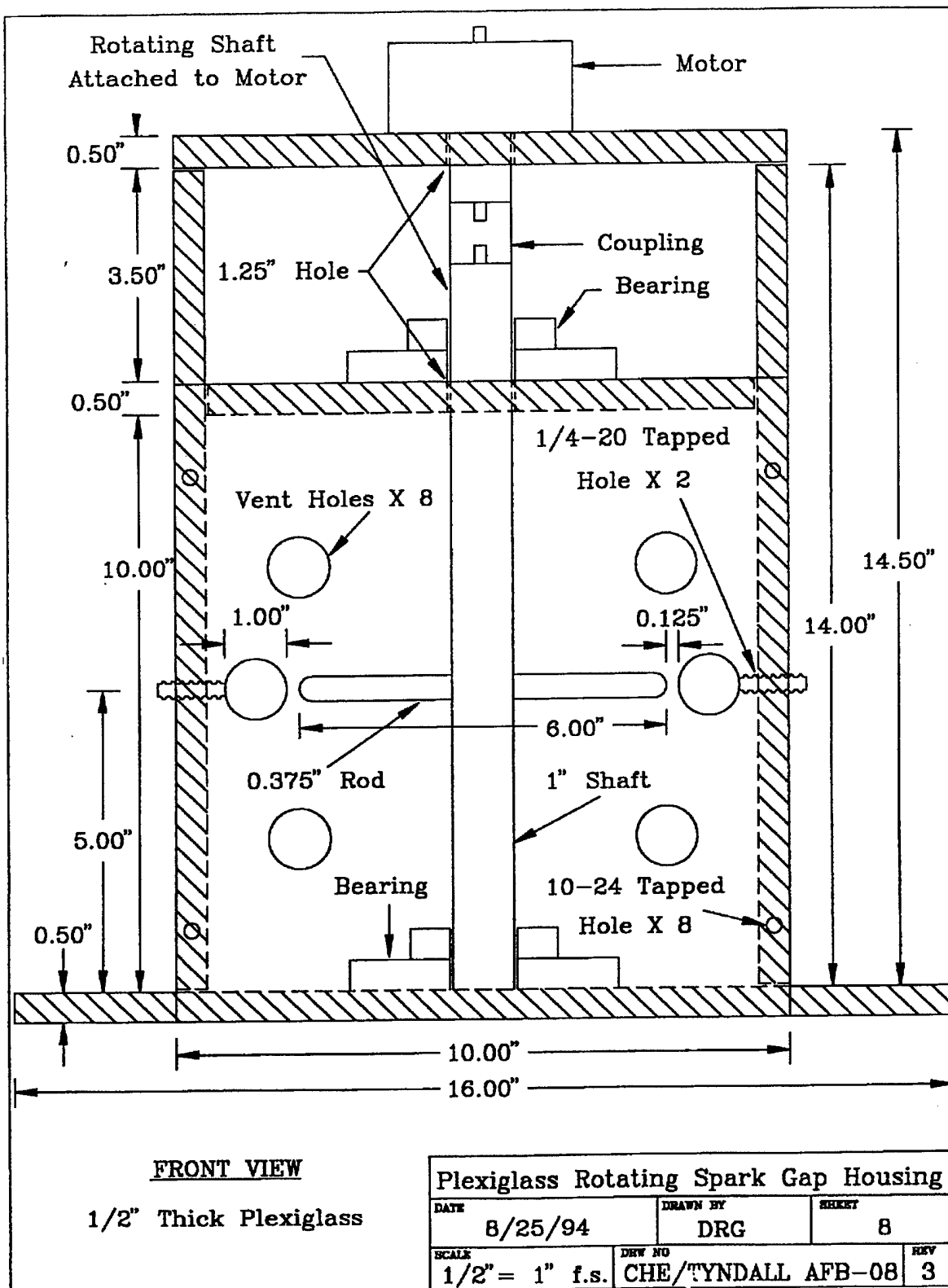


Figure 5. Plexiglas Rotating Spark Gap Housing - Front View

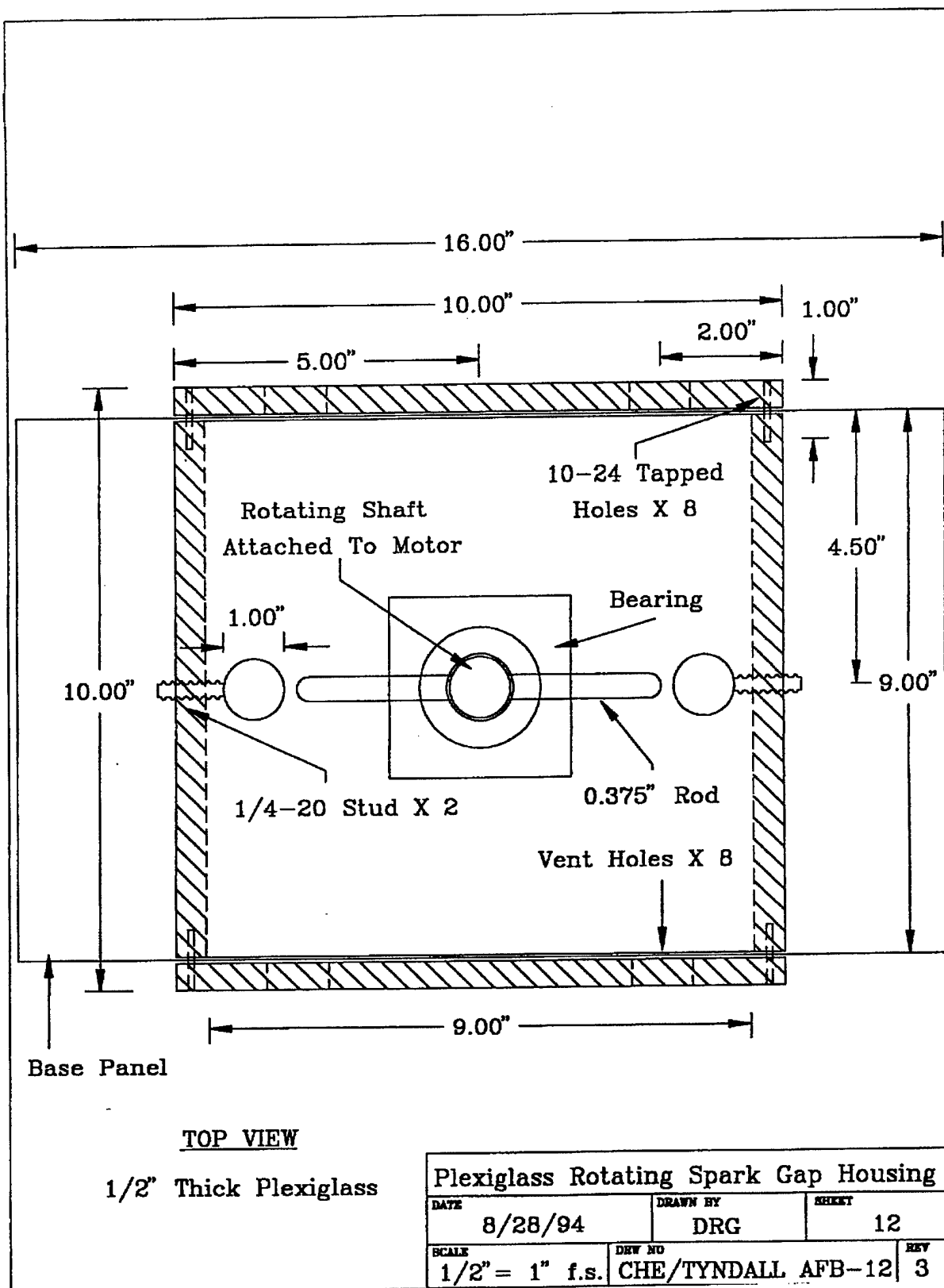


Figure 7. Plexiglas Rotating Spark Gap Housing - Top View

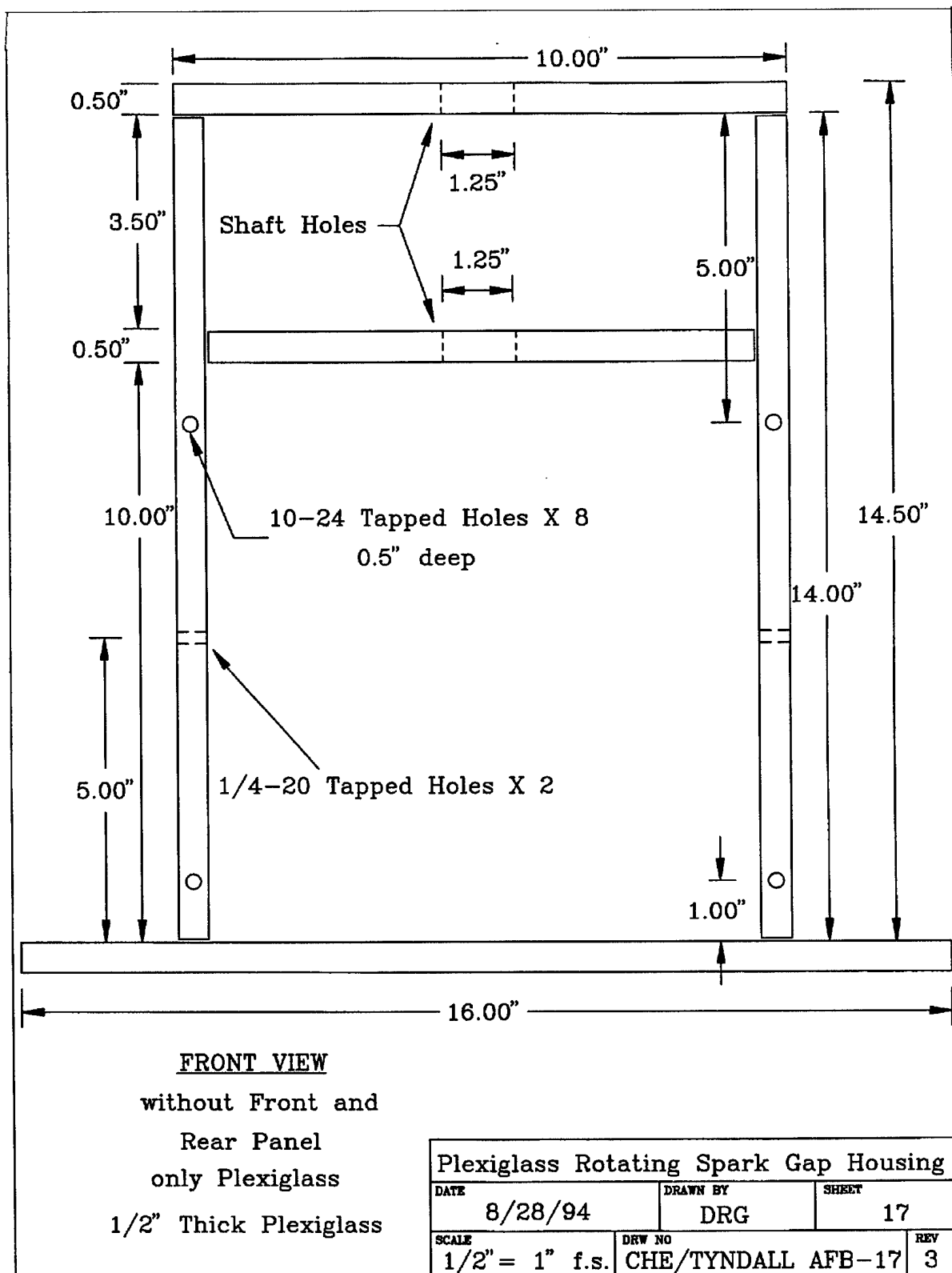


Figure 8. Plexiglas Rotating Spark Gap Housing - Front View (without Front and Rear Panels)

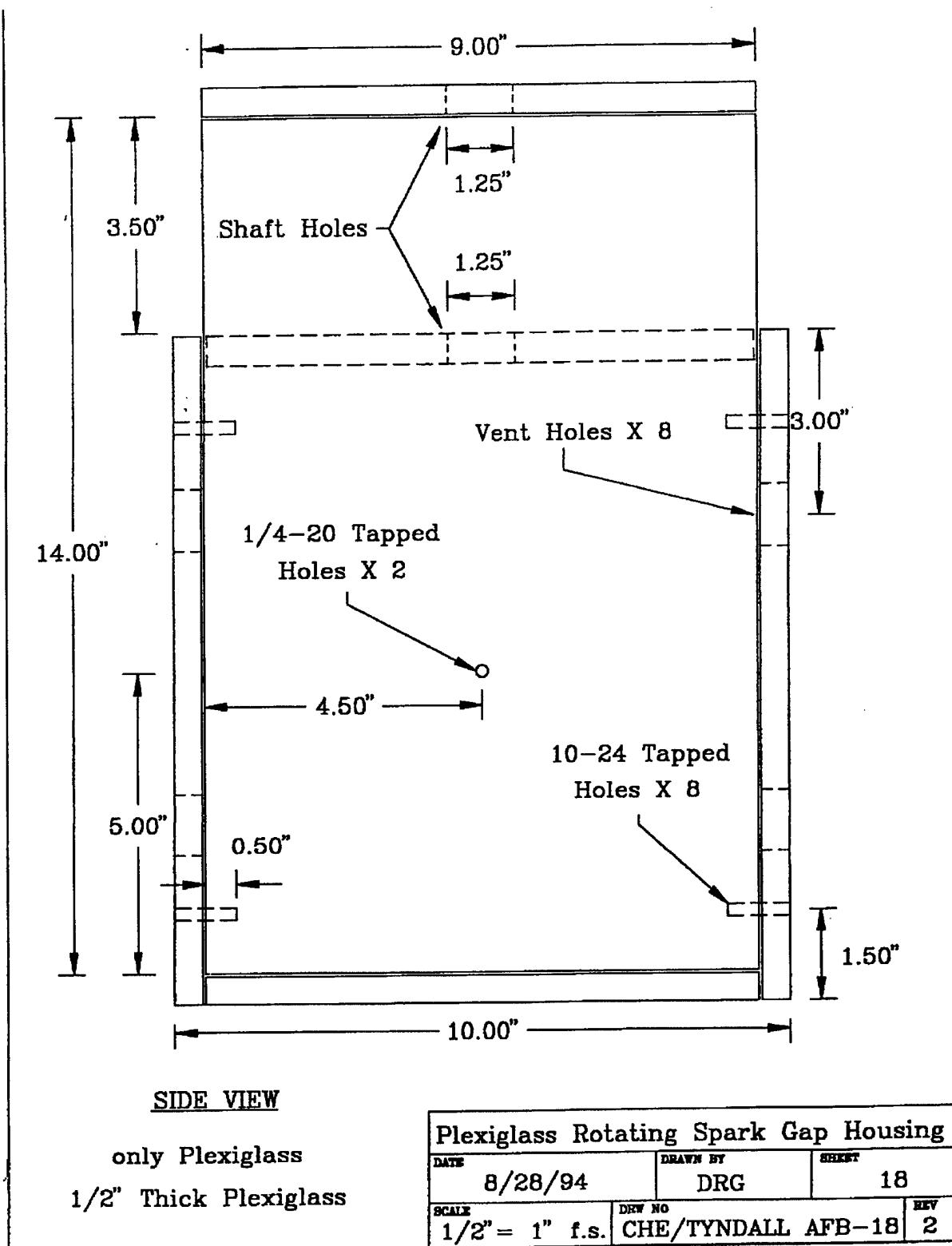


Figure 9. Plexiglas Rotating Spark Gap Housing - Side View (only Plexiglas)

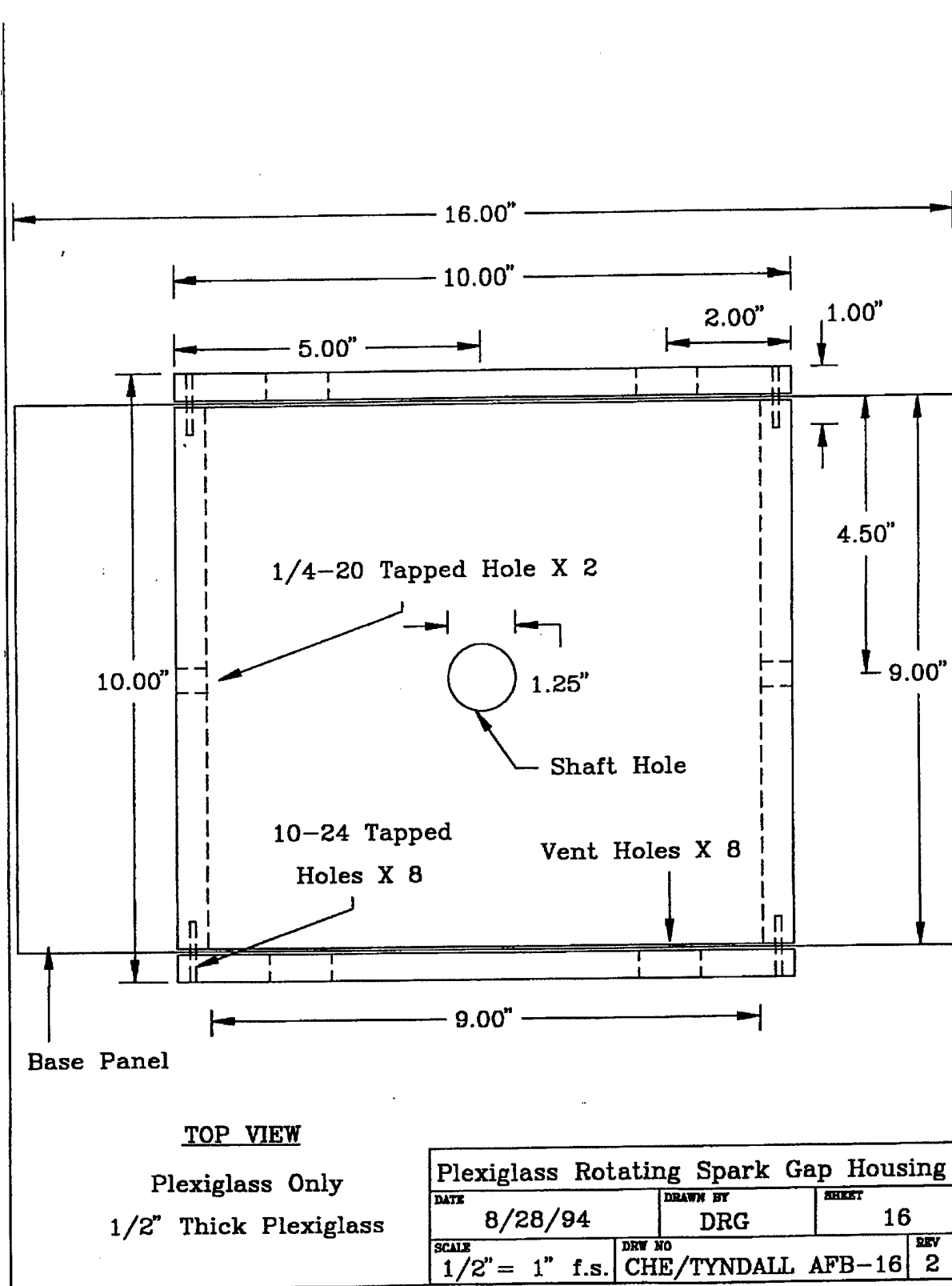
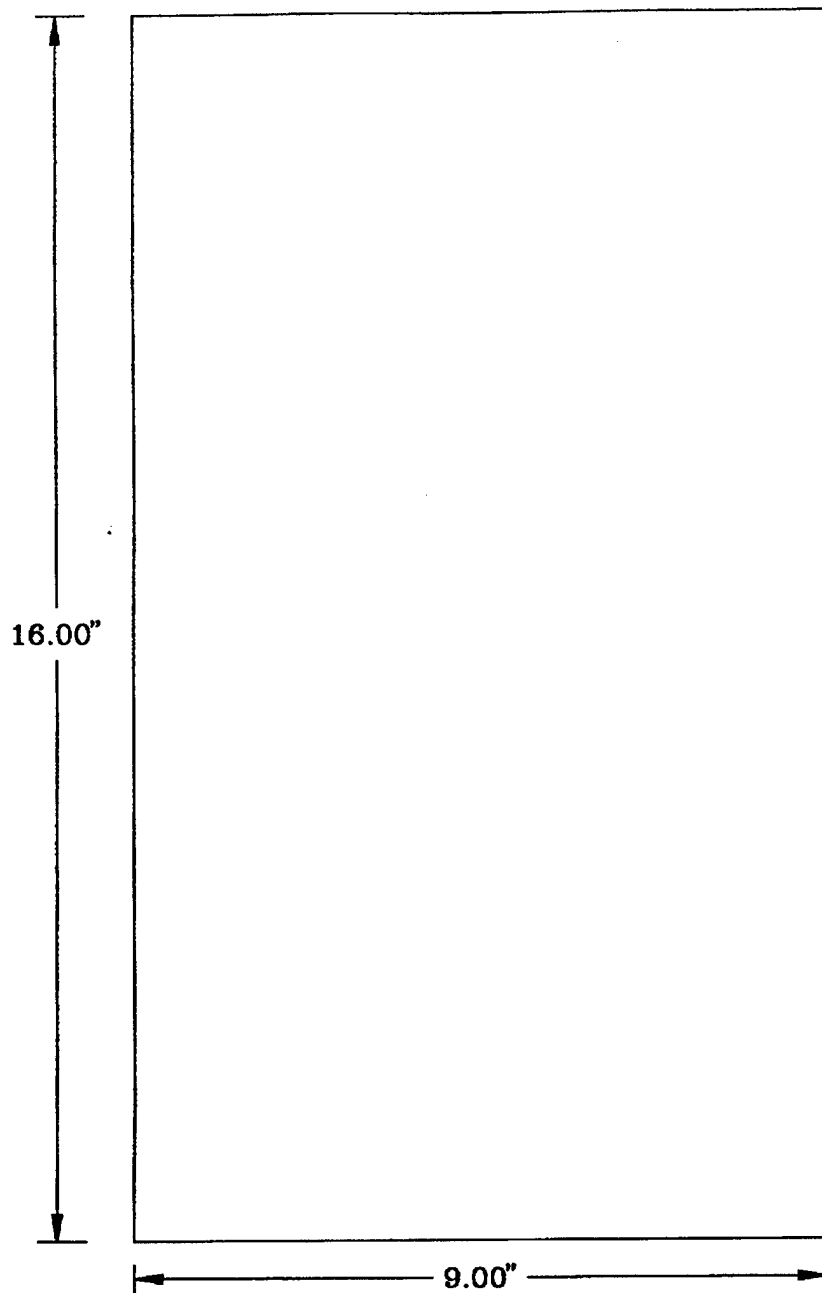


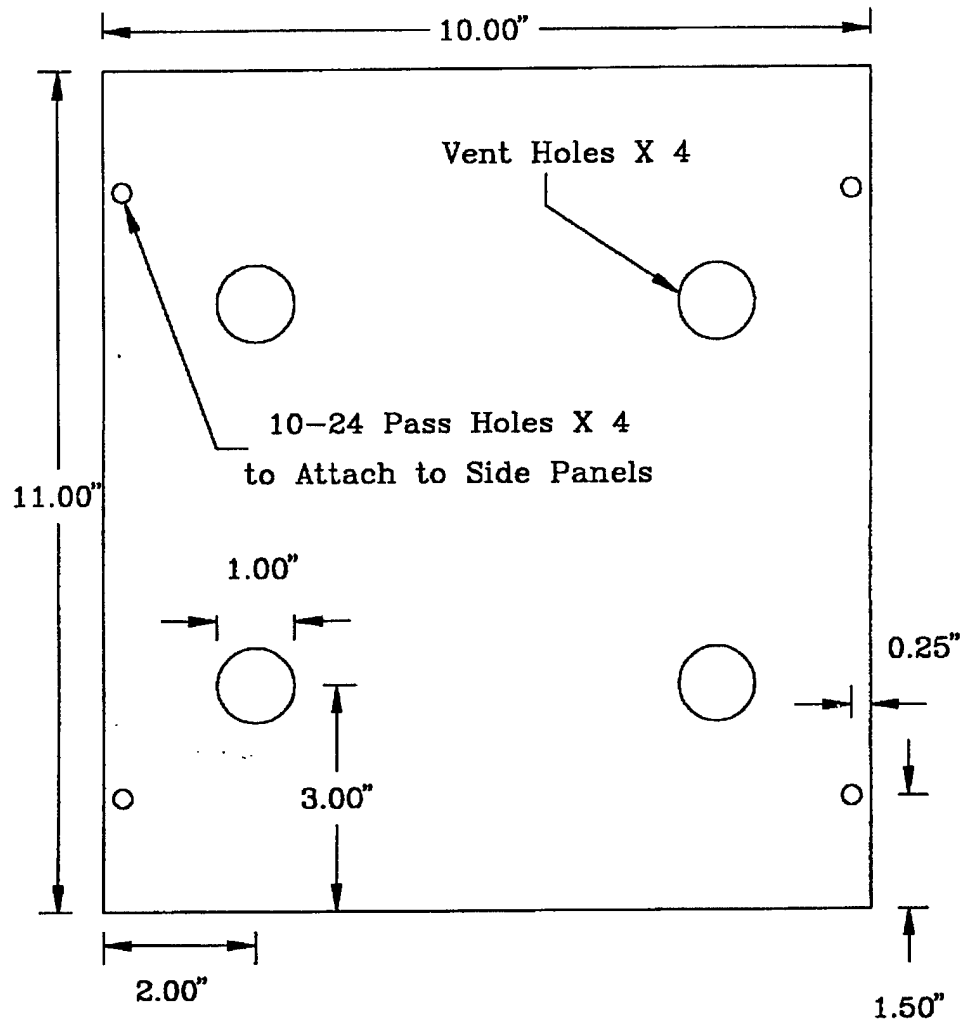
Figure 10. Plexiglas Rotating Spark Gap Housing - Top View (only Plexiglas)



BOTTOM PANEL
 1/2" Thick Plexiglass

Plexiglass Rotating Spark Gap Housing			
DATE	DRAWN BY	SHEET	
8/25/94	DRG	13	
SCALE	DRW NO	REV	
1/2" = 1" f.s.	CHE/TYNDALL AFB-13	2	

Figure 11. Plexiglas Rotating Spark Gap Housing - Bottom Panel



FRONT AND REAR PANEL

1/2" Thick Plexiglas

Plexiglas Rotating Spark Gap Housing			
DATE	8/27/94	DRAWN BY	DRG
SCALE	1/2" = 1" f.s.	DEW NO	CHE/TYNDALL AFB-09
		SHEET	9
		REV	3

Figure 12. Plexiglas Rotating Spark Gap Housing - Front and Rear Panel

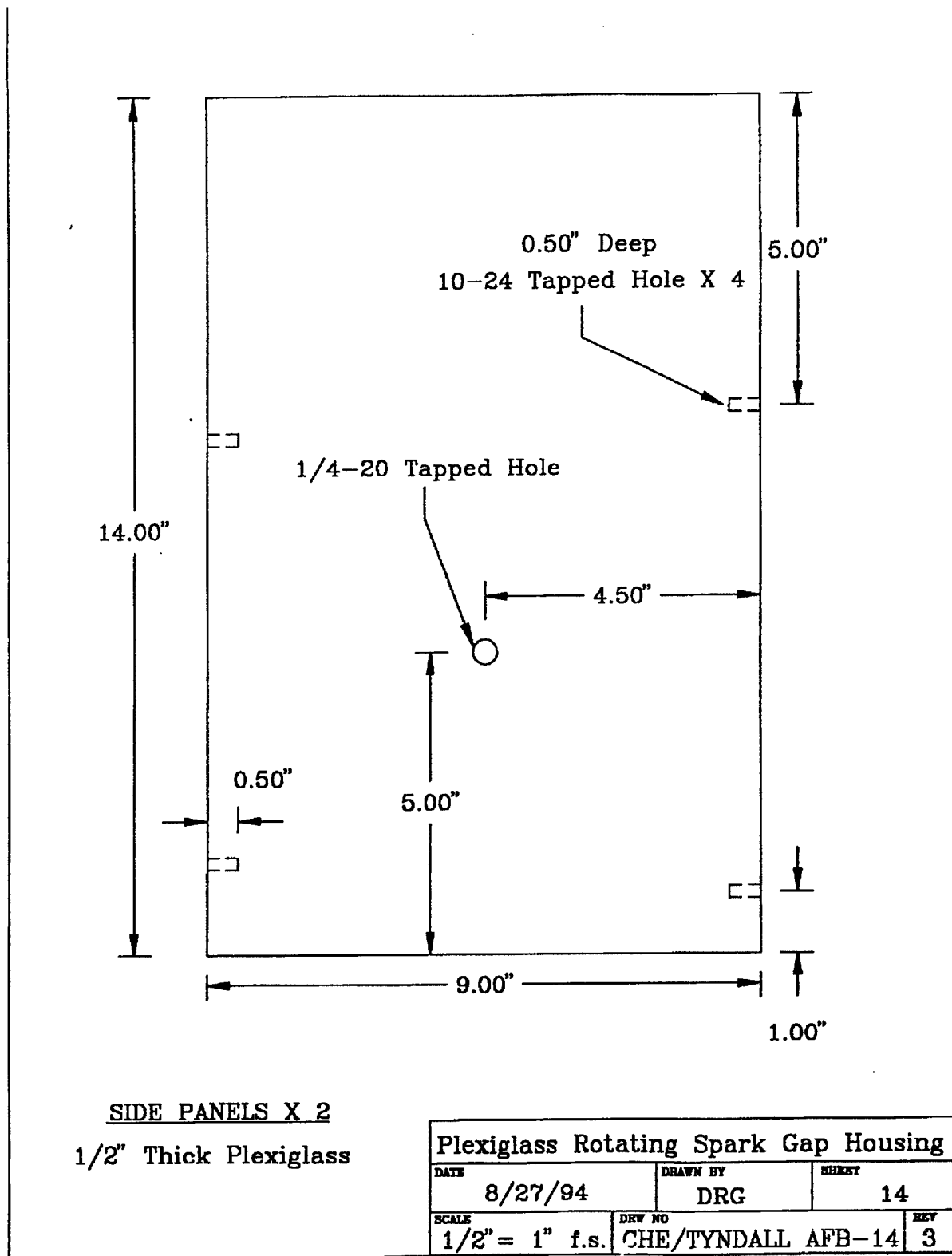
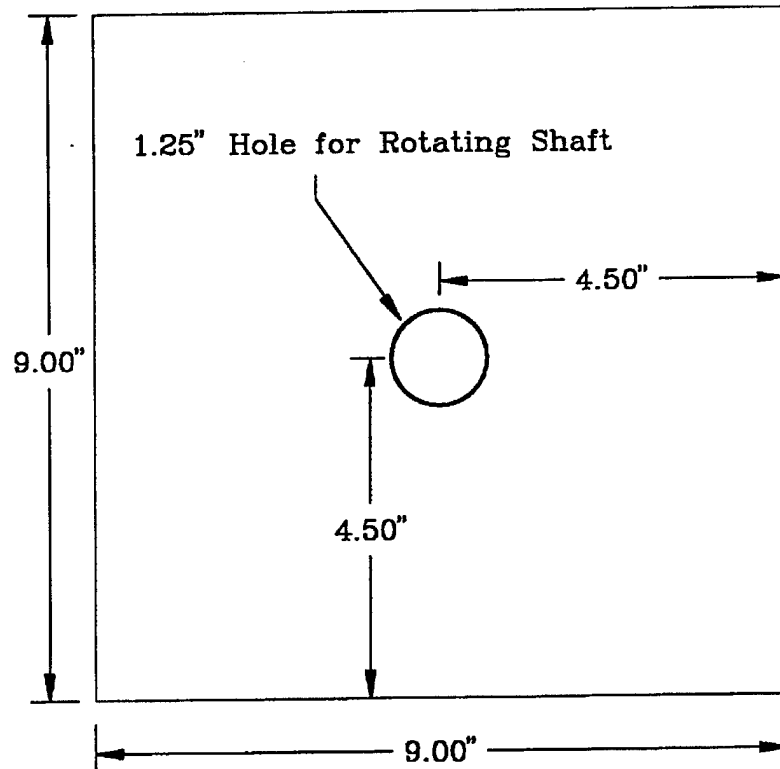


Figure 13. Plexiglas Rotating Spark Gap Housing - Side Panels

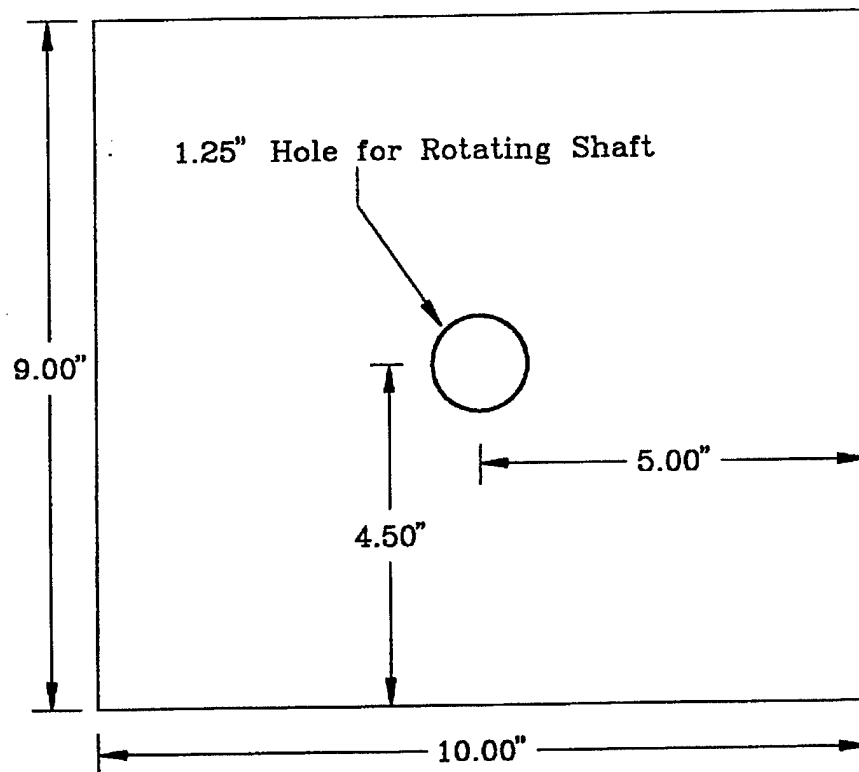


MIDDLE PANEL

1/2" Thick Plexiglass

Plexiglass Rotating Spark Gap Housing			
DATE	DRAWN BY	SHEET	
8/27/94	DRG	15	
SCALE	DRW NO	REV	
1/2" = 1" f.s.	CHE/TYNDALL AFB-15	3	

Figure 14. Plexiglas Rotating Spark Gap Housing - Middle Panel

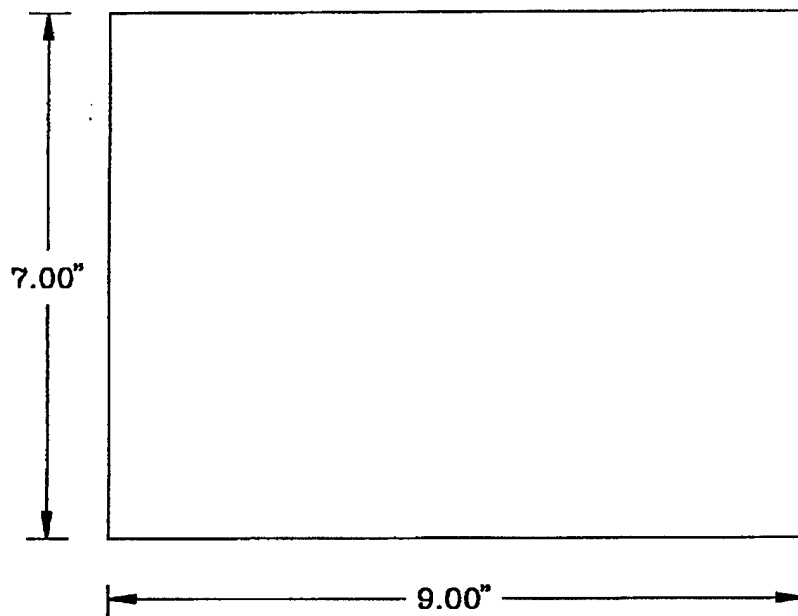


TOP PANEL

1/2" Thick Plexiglass

Plexiglass Rotating Spark Gap Housing			
DATE	8/27/94	DRAWN BY	DRG
		SHEET	19
SCALE	1/2" = 1" f.s.	DESIGN NO	CHE/TYNDALL AFB-19
		REV	1

Figure 15. Plexiglas Rotating Spark Gap Housing - Top Panel



MOTOR ATTACHMENT PANEL

1/2" Thick Plexiglass

Plexiglass Rotating Spark Gap Housing			
DATE	8/28/94	DRAWN BY	DRG
		SHEET	19
SCALE	1/2" = 1" f.s.	DRW NO	CHE/TYNDALL AFB-19
		REV	1

Figure 16. Plexiglas Rotating Spark Gap Housing - Motor Attachment Panel

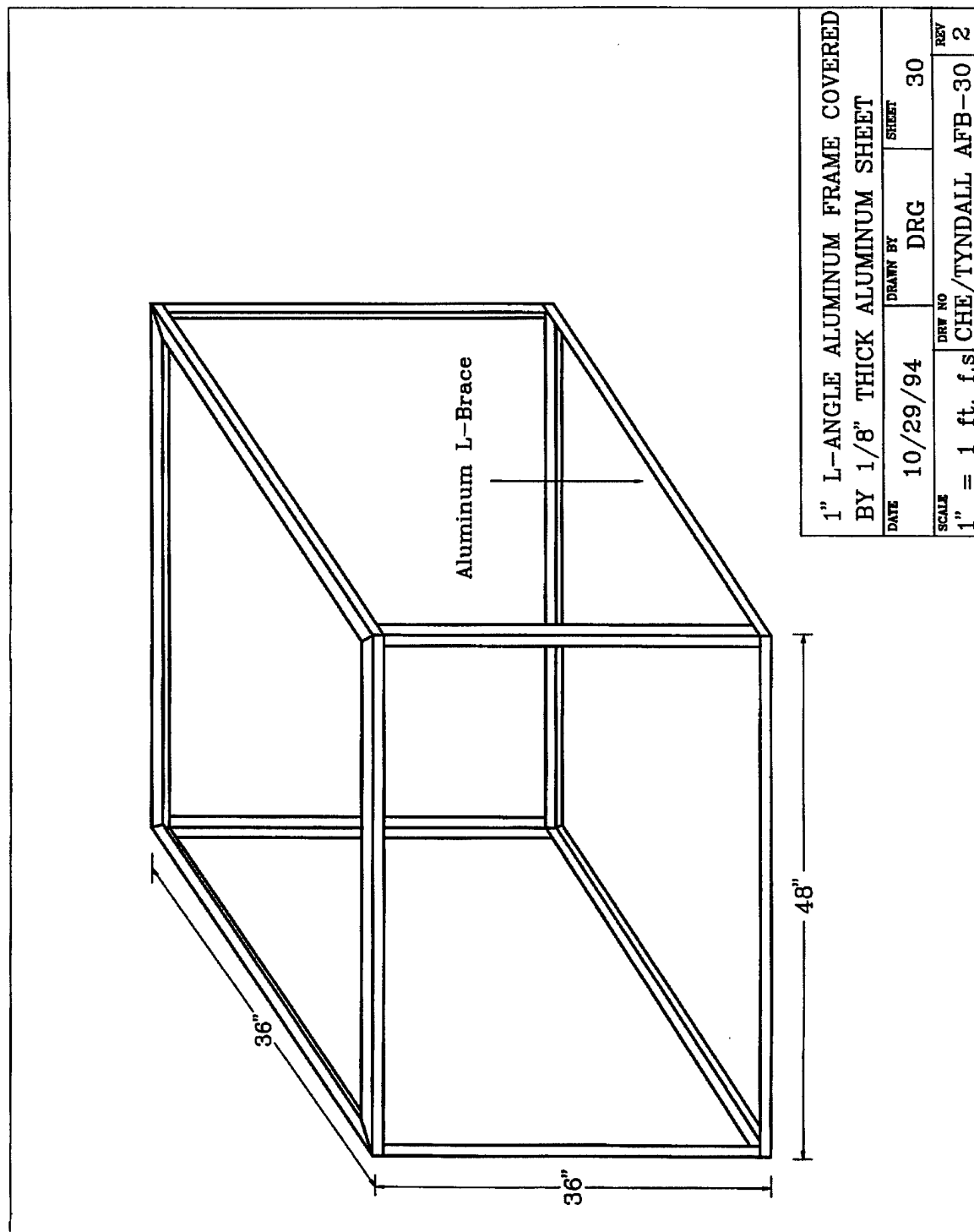


Figure 17. L-Angle Aluminum Frame Covered by 1/8" Thick Aluminum Sheet

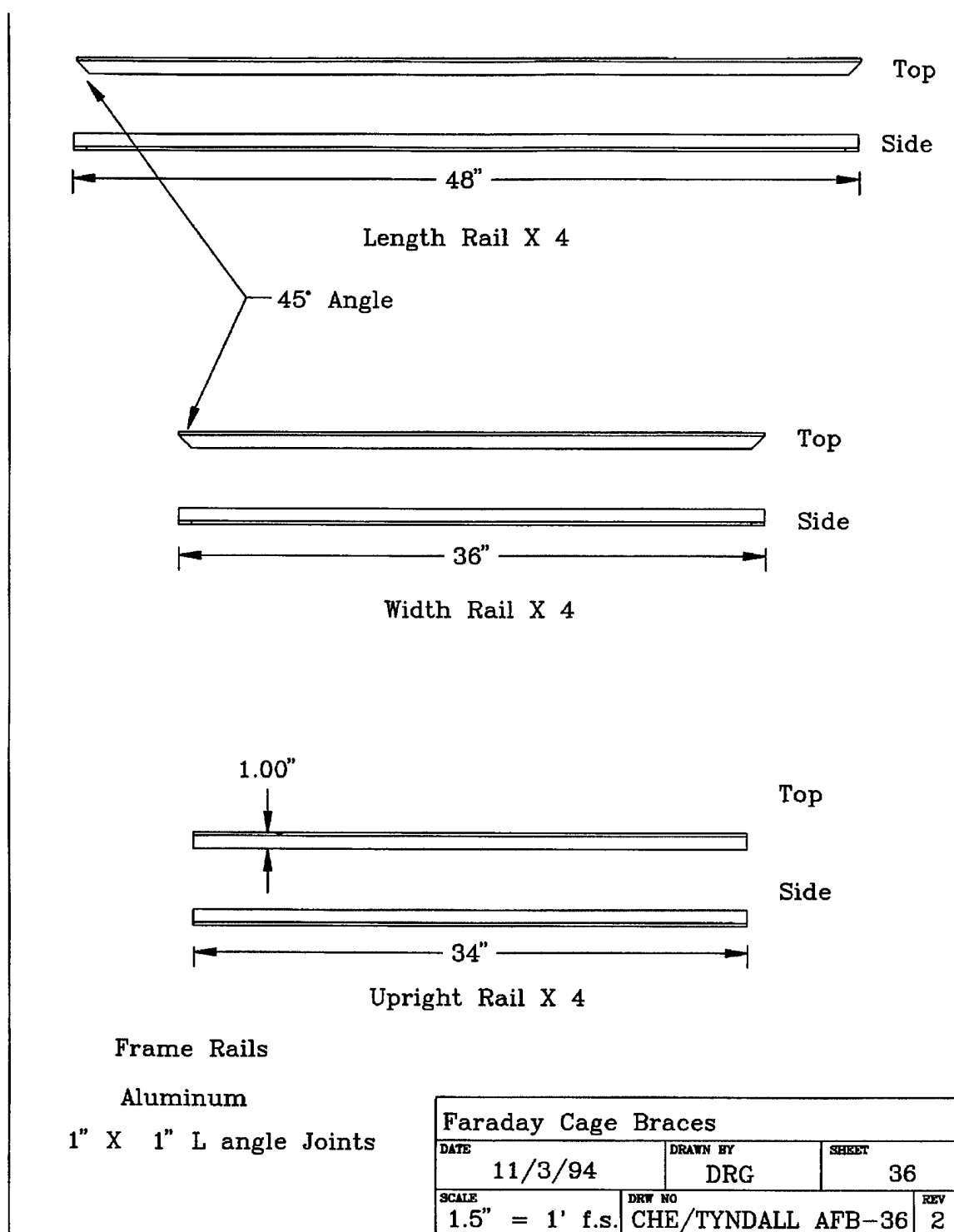


Figure 18. Faraday Cage Braces

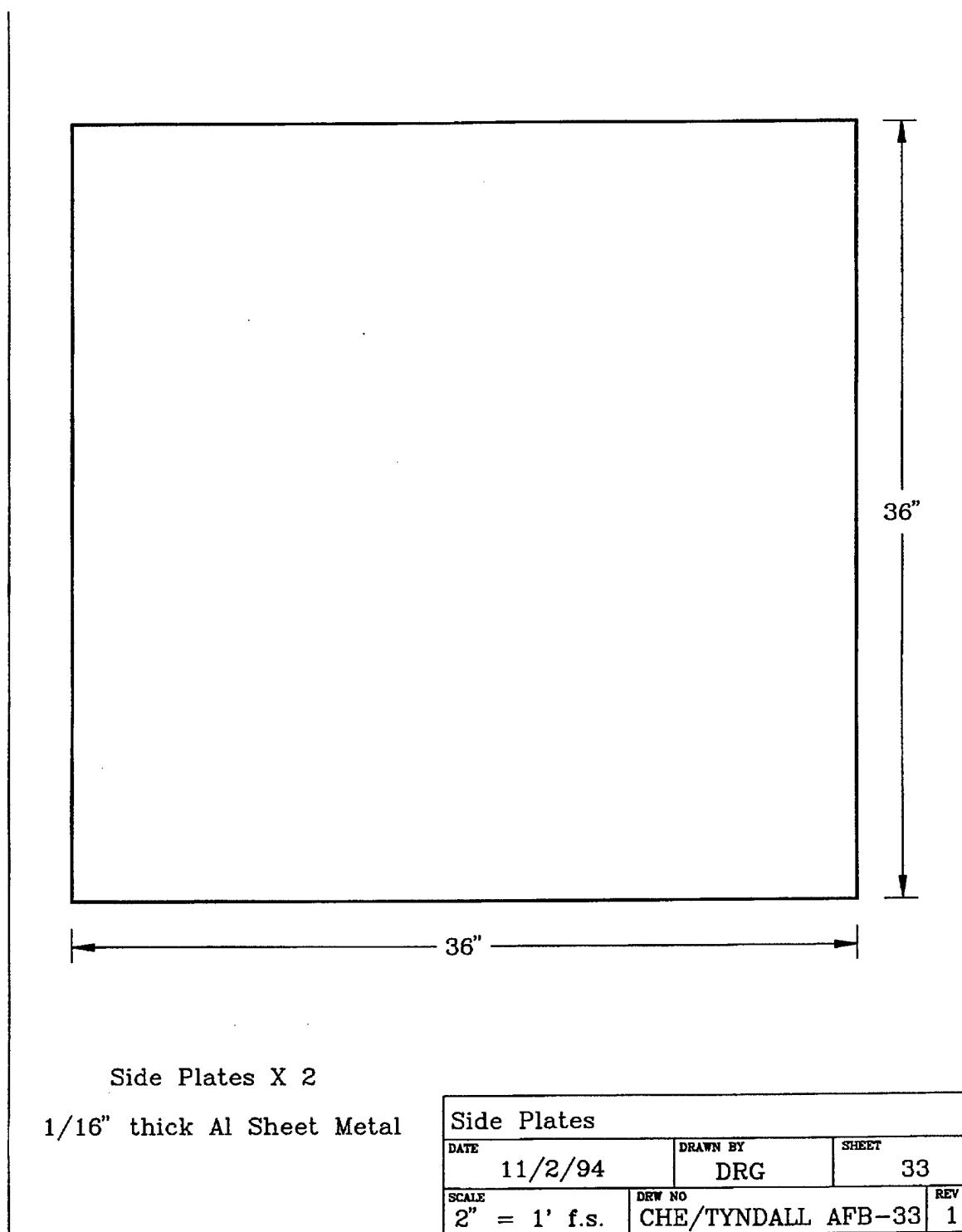


Figure 19. Faraday Cage Side Plates

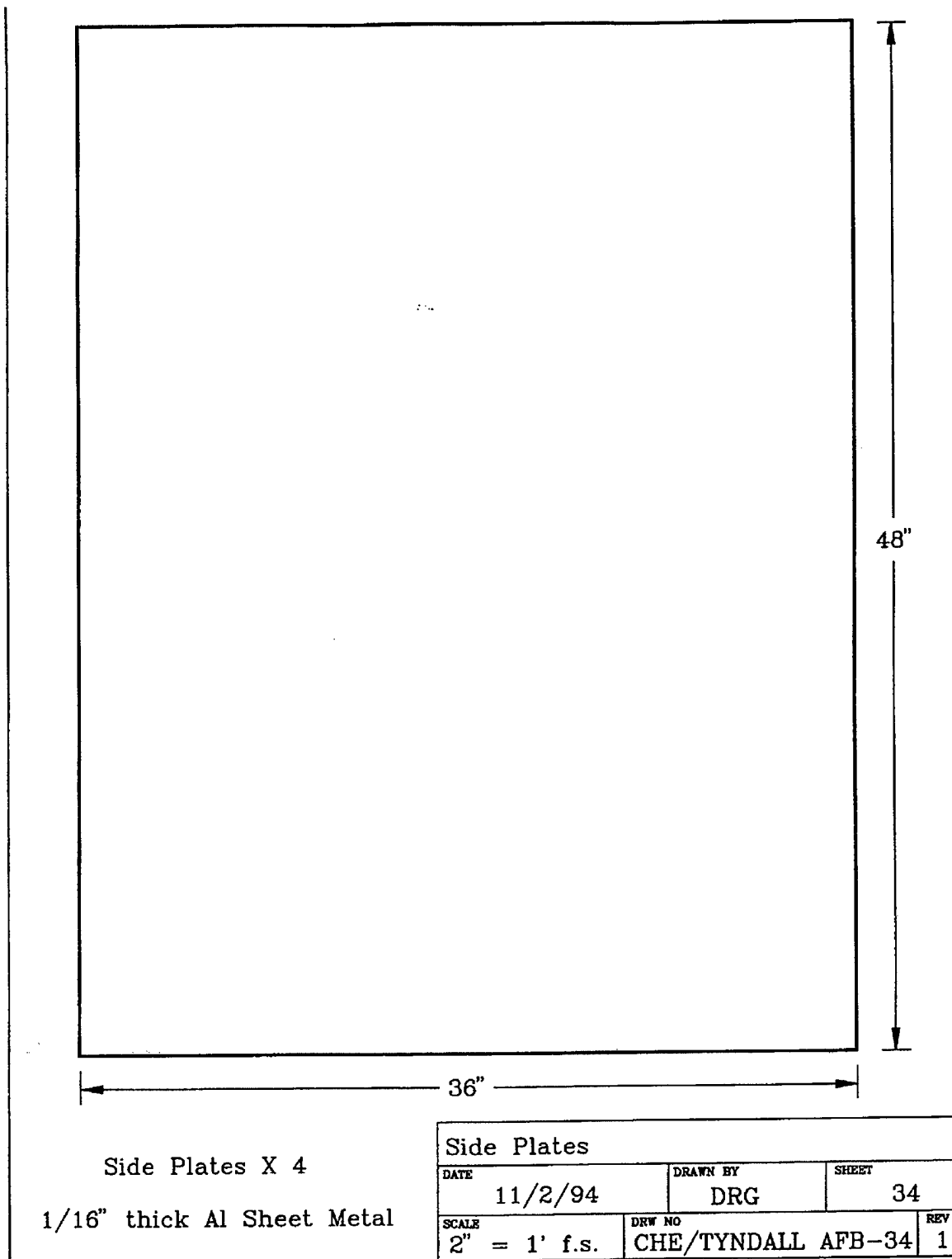


Figure 20. Faraday Cage Side Plates

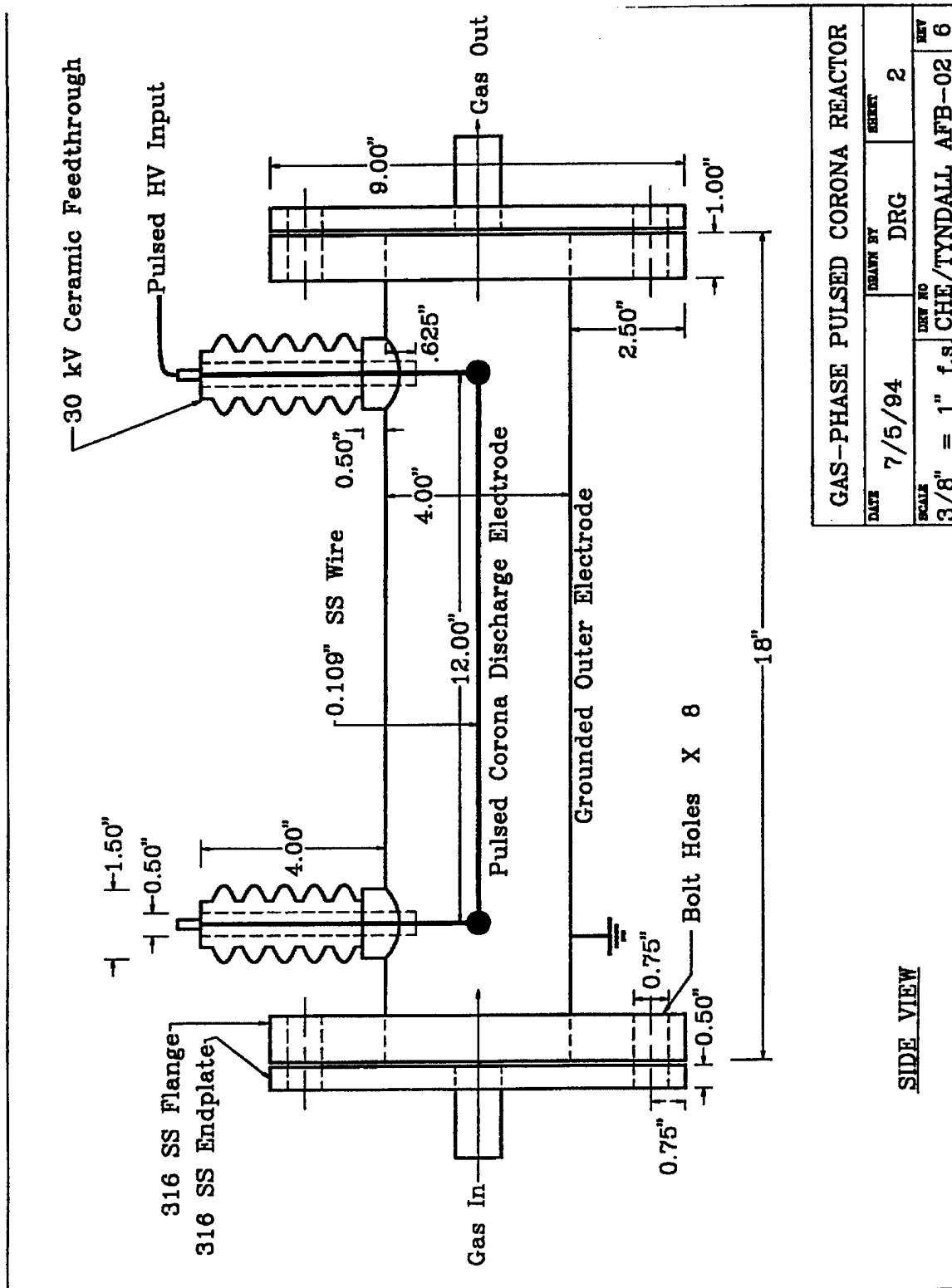


Figure 21. Gas-Phase Pulsed Corona Reactor - Side View

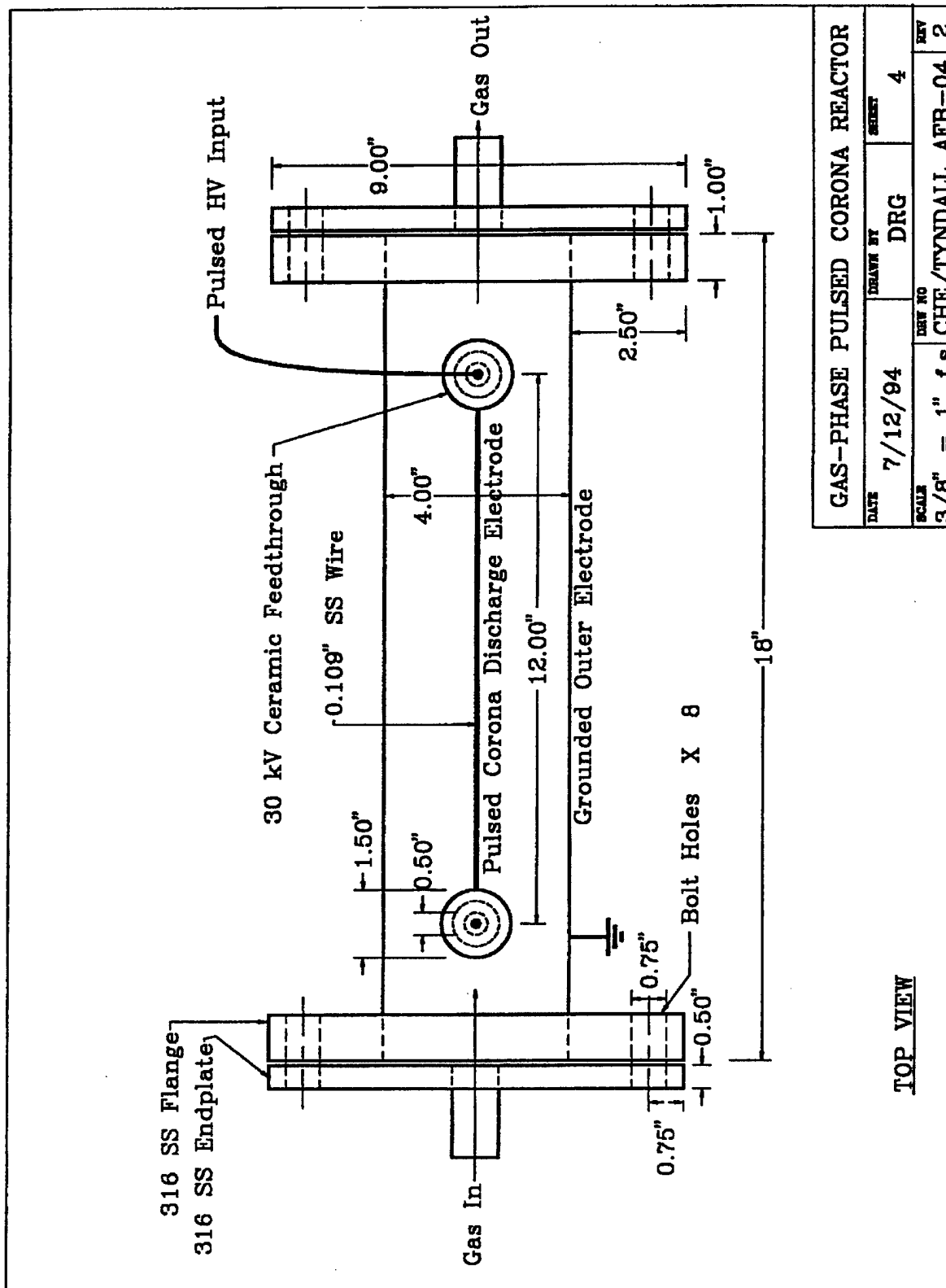


Figure 22. Gas-Phase Pulsed Corona Reactor - Top View

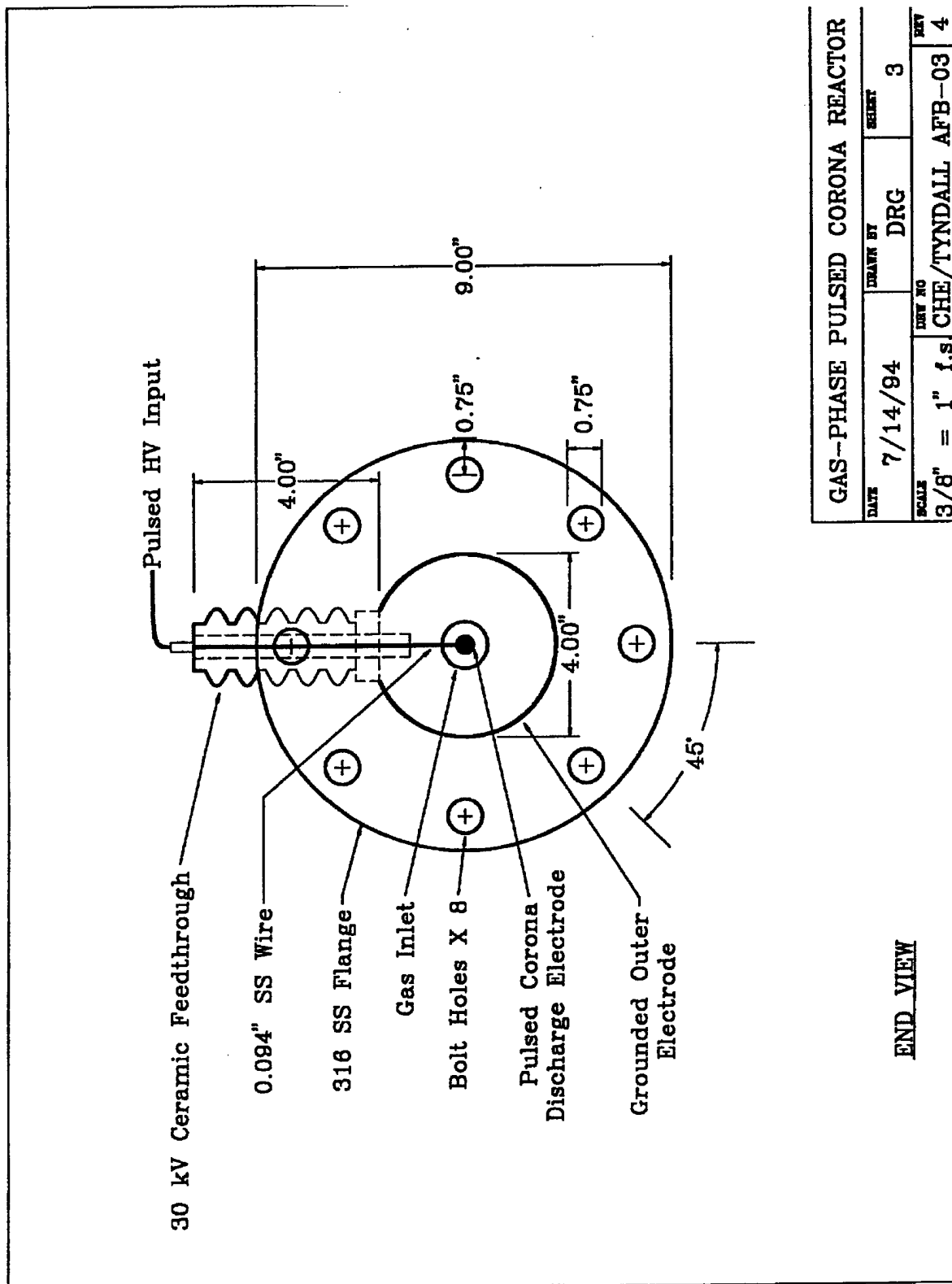


Figure 23. Gas-Phase Pulsed Corona Reactor - End View

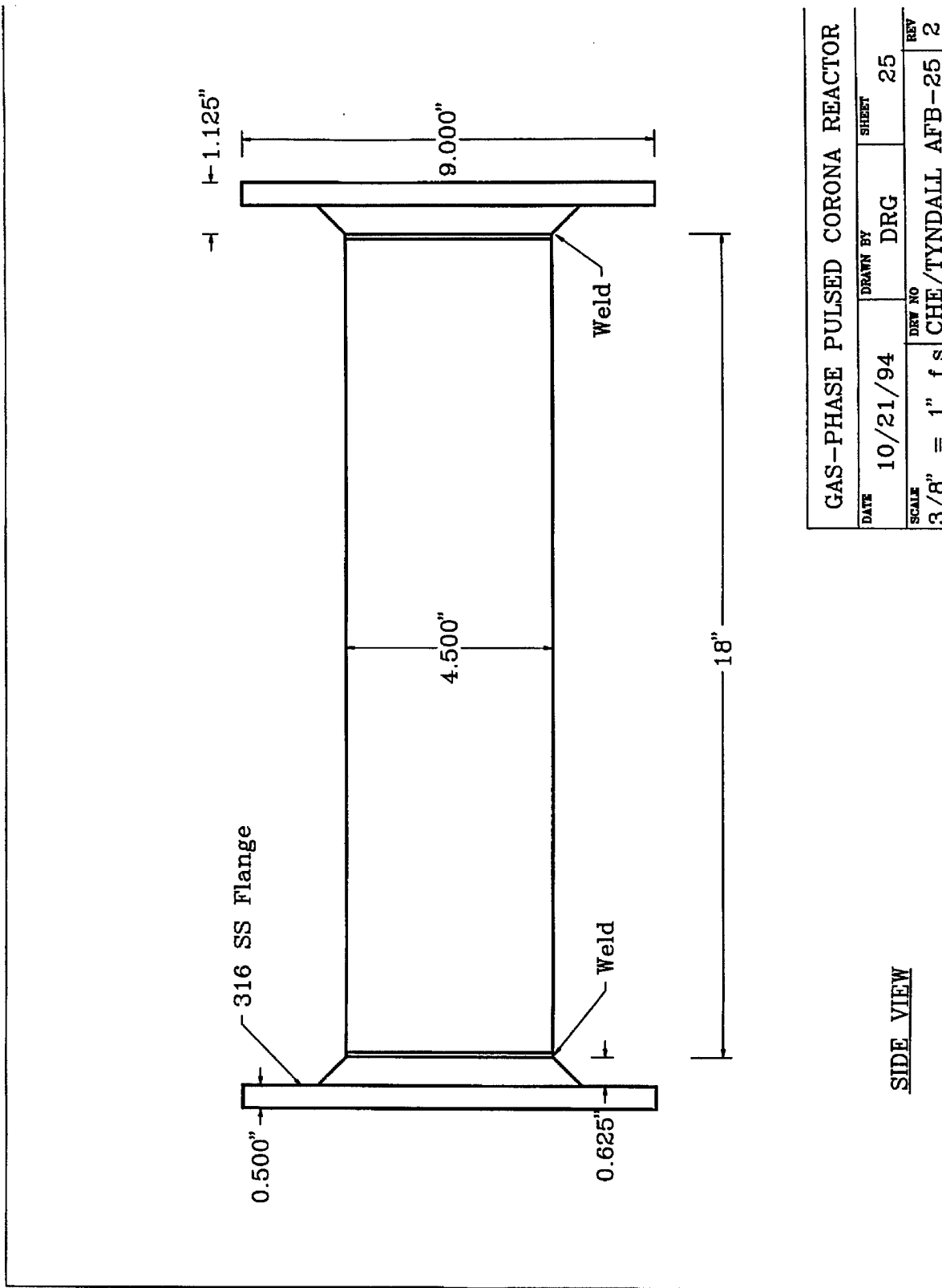
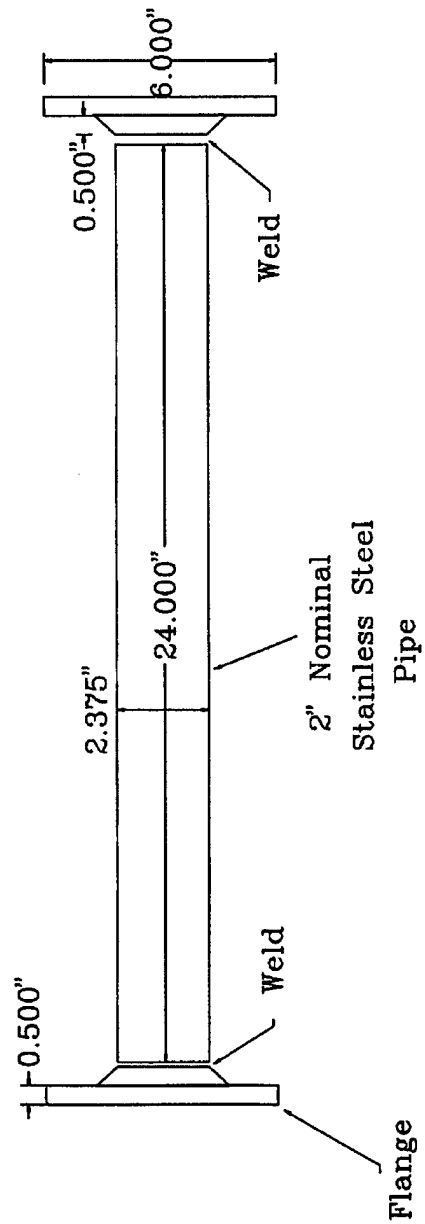


Figure 24. Stainless Steel Tube Portion of Reactor - Side View



SIDE VIEW

GAS MIXING CHAMBER			
DATE	10/13/94	DRAWN BY	DRG
SCALE	1/4" = 1" f.s	DRW NO	CHE/TYNDALL AFB-26
		SHEET	26
		REV	1

Figure 25. Gas Mixing Chamber - Side View

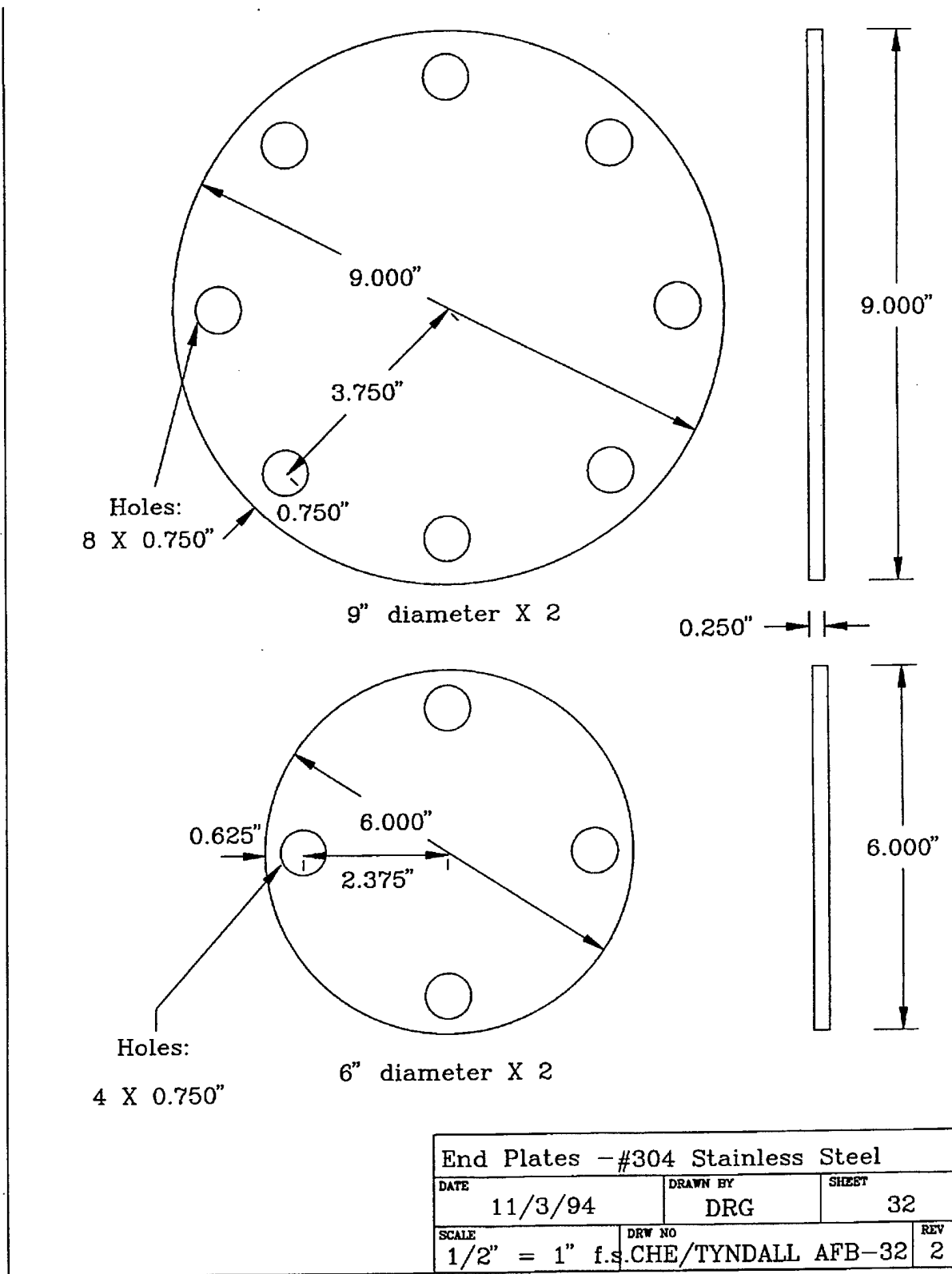


Figure 26. End Plates for Pulsed Corona Reactor

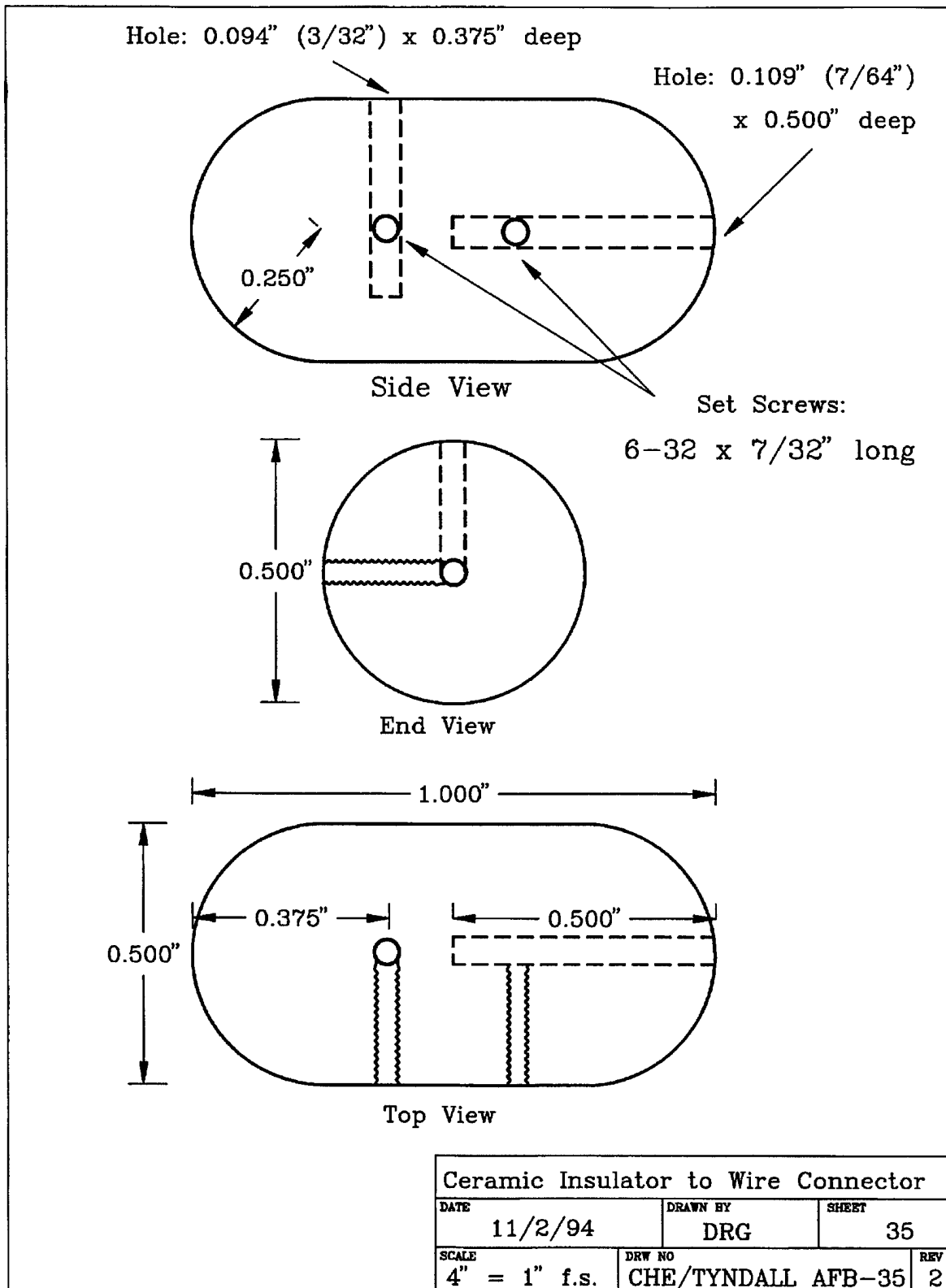
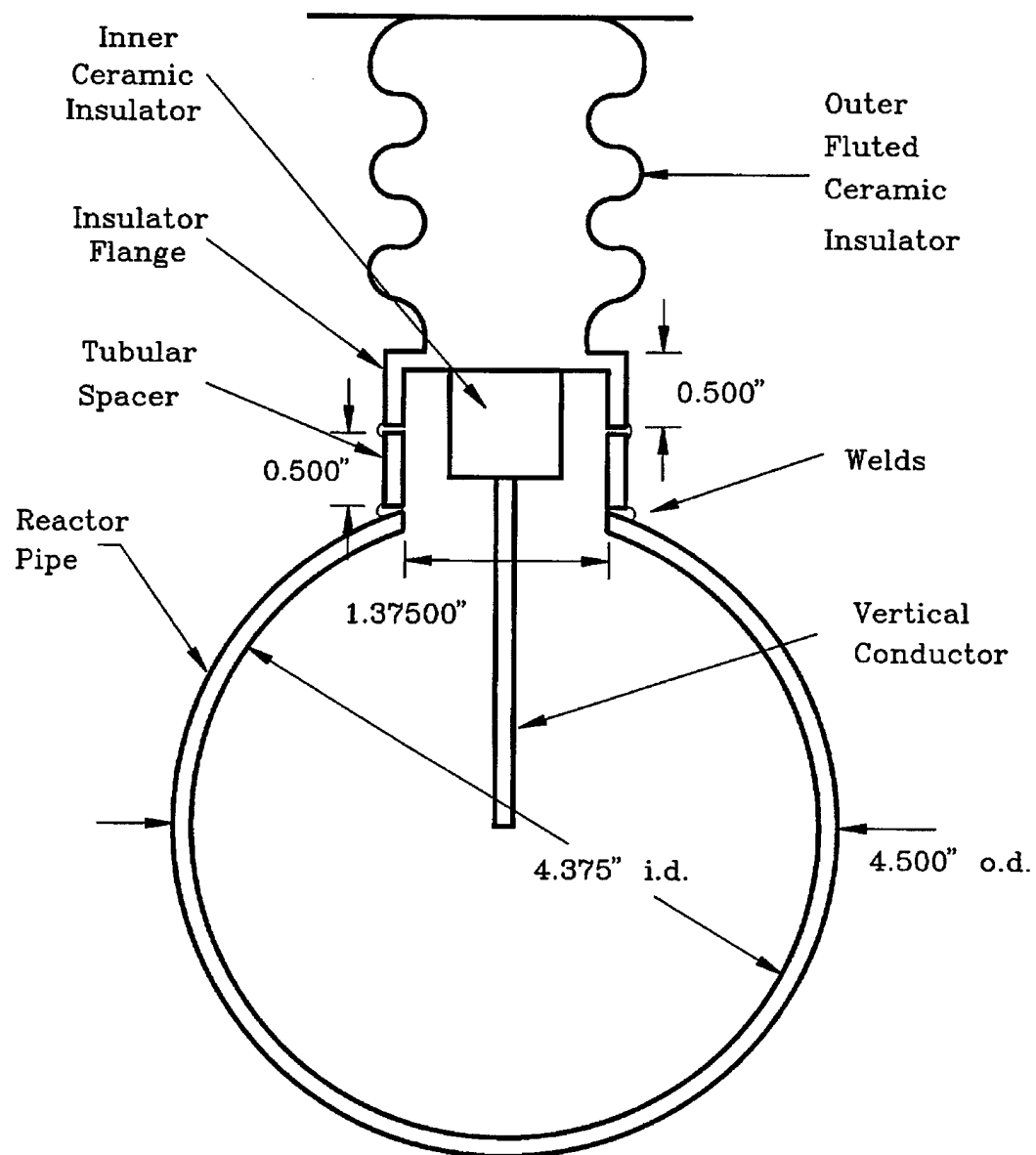


Figure 27. Ceramic Insulator to Wire Connector



Detail of Ceramic Insulator
to Reactor Connection

DATE	7/27/94	DRAWN BY	DRG	SHEET	7
SCALE	1" = 1" f.s.	DRW NO	CHE/TYNDALL AFB-07	REV	4

Figure 28. Detail of Ceramic Insulator to Reactor Connection

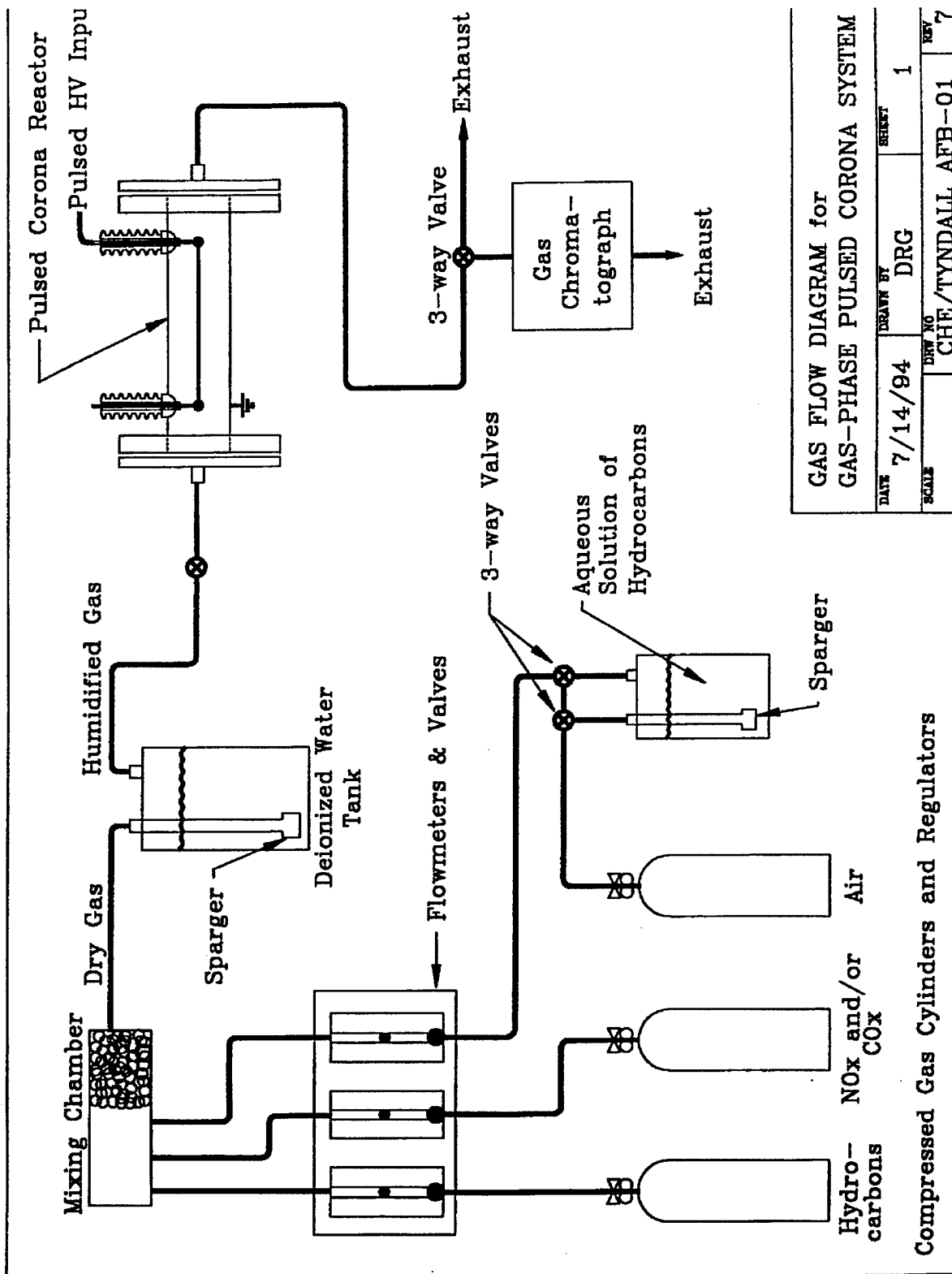


Figure 29. Gas Flow Diagram for Gas-Phase Pulsed Corona System

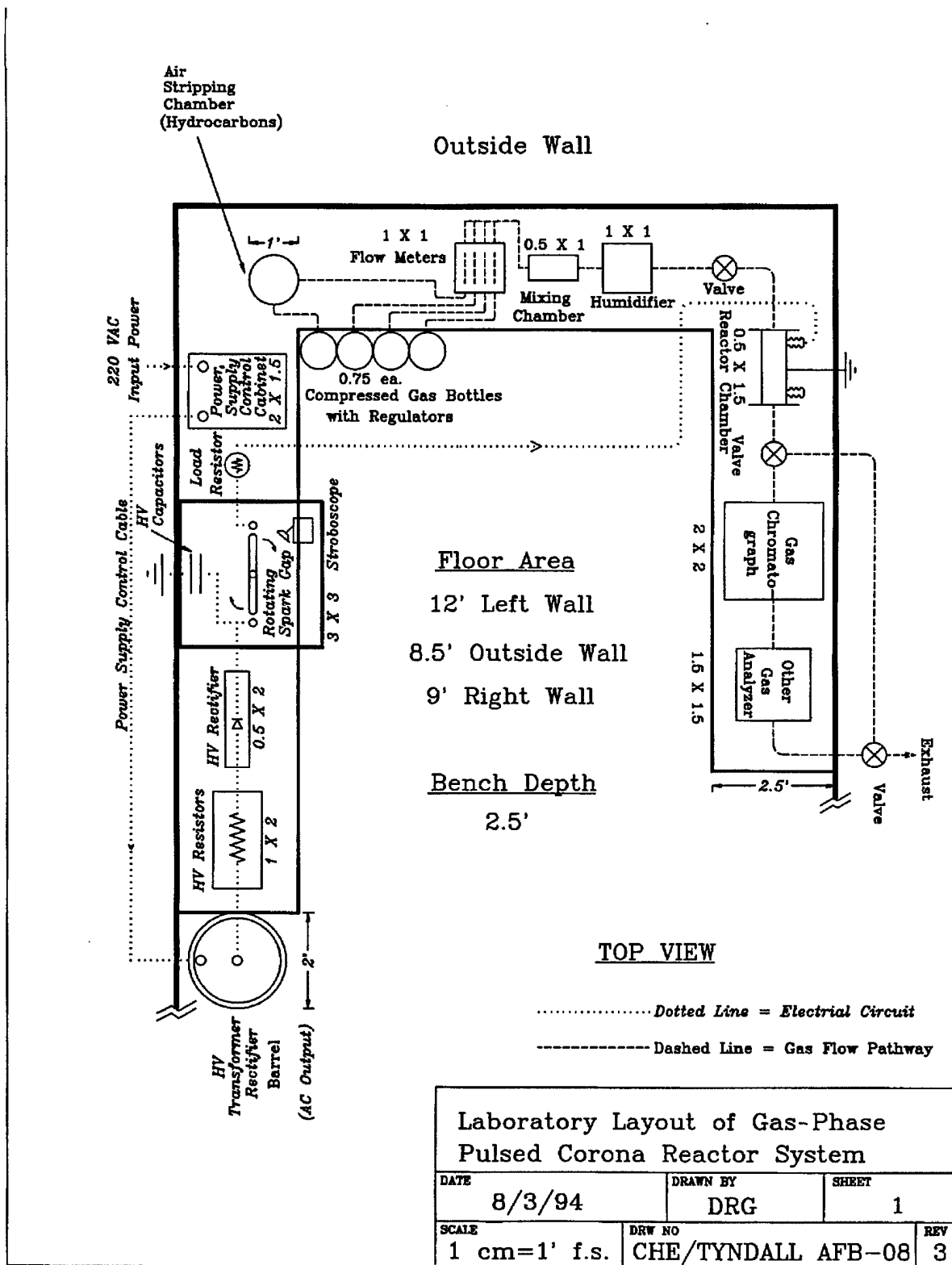


Figure 30. Laboratory Layout of Gas-Phase Pulsed Corona Reaction System

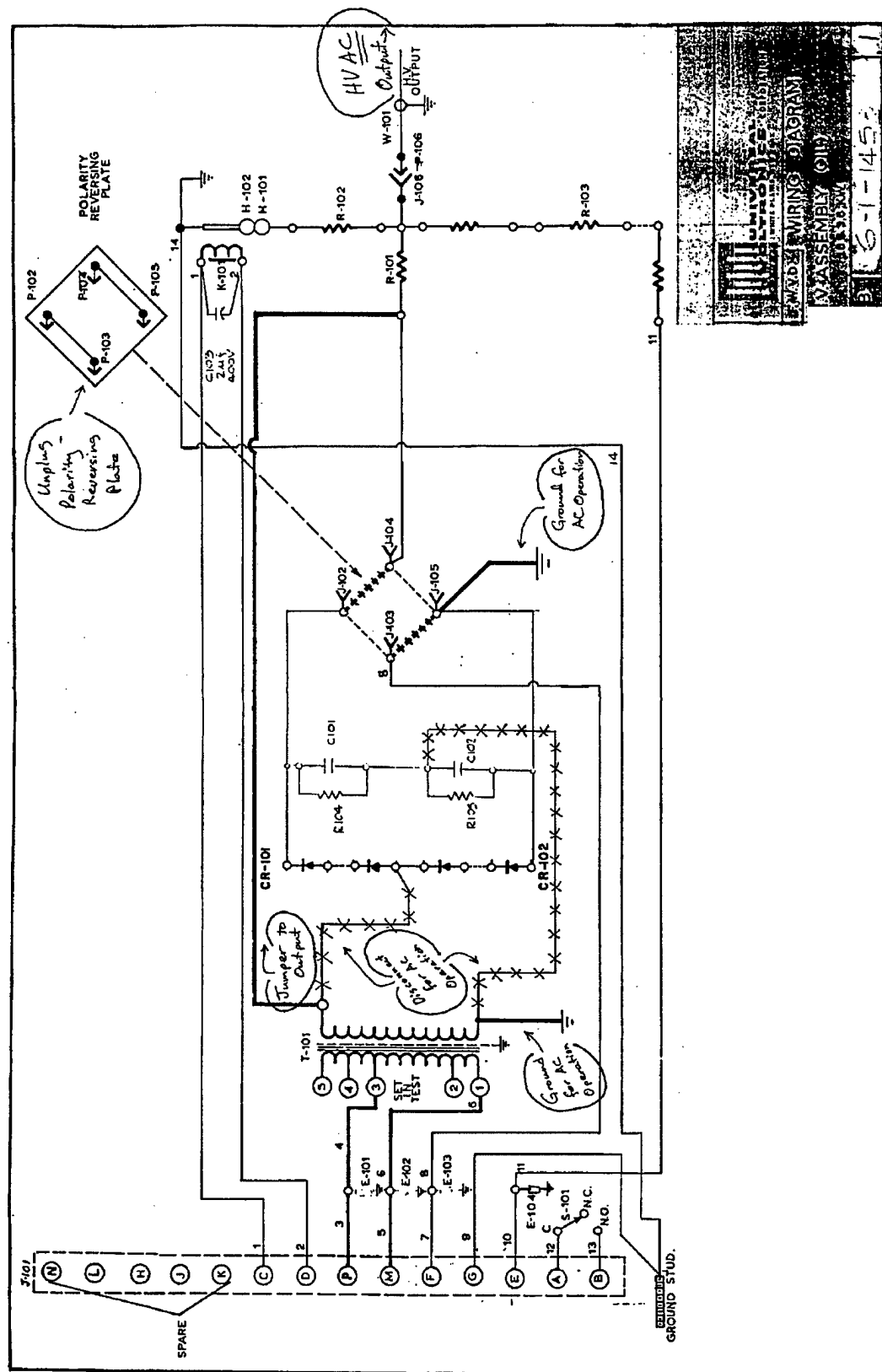


Figure 31. Schematic of Universal Voltronics Power Supply for AC Output

IX. APPENDICES

APPENDIX I - Equipment and Parts Lists



DEPARTMENT OF THE AIR FORCE

ARMSTRONG LABORATORY (AFMC)

TYNDALL AIR FORCE BASE, FLORIDA

FROM: AL/EQC (TSgt Junn 283-6071)

6 Dec 94

MEMORANDUM FOR RECORD

SUBJECT: FSU Receiving Supplies Purchased For Dr Wander's Program

The following items are for Research Project on Pulsed Streamer Corona Treatment of Gas and Liquid Contaminants:

- | | |
|--|-----|
| ✓ 1. Digitizing Storage Oscilloscope | IEA |
| ✓ 2. Front cover and accessories pouch | IEA |
| ✓ 3. Color Plotter | IEA |
| ✓ 4. Probe | IEA |
| ✓ 5. Current Probe System | IEA |

All equipment and materials listed above are supplies for Contract FO8637-94-FB-554. These items will be used only toward the design and construction of a pulsed corona reactor and supporting equipment as outlined in the statement of work in the contract.

W.C. Finney
RECEIVED BY:

12-20-94
DATE RECEIVED:

PRINT NAME:

W.C. Finney

PHONE #

(904) 487-6309



DEPARTMENT OF THE AIR FORCE

ARMSTRONG LABORATORY (AFMC)
TYNDALL AIR FORCE BASE, FLORIDA

FROM: AL/EQC (TSgt Junn 283-6003)

21 Sep 94

MEMORANDUM FOR RECORD

SUBJECT: FSU Receiving Supplies Purchased For Dr Wanders Program

The following items are for Research Project on Pulsed Streamer Corona Treatment of Gas and Liquid Contaminants:

- | | |
|--|---------|
| ✓ 1. Swagelok Kit consisting of: SEE ATTACHED LIST | 2 each |
| ✓ 2. Aluminum Flat Sheets 1/16" X 48" X 144" | 2 each |
| ✓ 3. Aluminum Extruded L-Angle 1" X 1" X 25' | 3 each |
| ✓ 4. Stainless Steel Pipe 4" X 12' | 1 each |
| ✓ 5. Stainless Steel Pipe 2" X 12' | 1 each |
| ✓ 6. Power-Mox Resistor 1000 | 5 each |
| ✓ 7. Q-BNMX-16 Ball Stainless Steel 1" Dia. | 4 each |
| ✓ 8. Brazed 1/4 -20 X 3" SS Threaded Stud to above item #7 | 4 each |
| ✓ 9. Round Bar SS 3/8" X 12" | 1 each |
| ✓ 10. Round Bar, SS 1/2" X 12" | 1 each |
| ✓ 11. Round Rod 1" X 24" | 1 each |
| ✓ 12. Round Rod, 1 1/2" X 24" | 1 each |
| ✓ 13. Threaded Rod, SS 1/4-20 X 24" | 1 each |
| ✓ 14. Center Drill, size 0 | 4 each |
| ✓ 15. Tap Wrench Q-HSTW-6B 5 3/4" Long | 1 each |
| ✓ 16. Carbon Film Resistor 1 Megohm | 10 each |
| ✓ 17. High Voltage Ceramic Capacitors | 25 each |

All equipment and materials listed above are supplies for Contract FO86379-94-M-6015. These items will be used only toward the design and construction of a pulsed corona reactor and supporting equipment as outlined in the statement of work in the contract.

W.C. Finney
RECEIVED BY:

9-21-94
DATE RECEIVED:

PRINT NAME: WRIGHT C. FINNEY

PHONE # (904) 487-6309
487-6149



DEPARTMENT OF THE AIR FORCE

ARMSTRONG LABORATORY (AFMC)
TYNDALL AIR FORCE BASE, FLORIDA

MEMORANDUM FOR RECORD

3 Oct 94

FROM: AL/EQC (TSgt Junn 283-6071)

SUBJECT: FSU Receiving Supplies Purchased For Dr. Wander's Program

1. The item listed below is for Research Project on Pulsed Streamer Corona Treatment of Gas and Liquid Contaminants:

High Voltage DC Power Supply SN: 94-9-6011, Model: BAL-130-28-T, 1 each.

2. All equipment and materials listed above are supplies for Contract FO86379-94-M-6015. These items will be used only toward the design and construction of a pulsed corona reactor and supporting equipment as outlined in the statement of work in the contract.

W.C. Finney
RECEIVED BY:

10-3-94
DATE RECEIVED:

PRINT NAME: *Wright C. Finney*

PHONE # *(904) 487-6149 or*
487-6151

Assoc. in Research

Dept. of Chemical Engr.

FAMU / FSU Coll. of Engr.

SUBMIT TO: F. HISING DEPARTMENT
2. OOTE-HILYER ADM. CTR.

Department Chemical Engineering
Account No. 190800001
Date 1/19/95
Initiated by B. Scott 487-6151 Ext. _____
Approved by _____
Approved by _____
Head of Department _____
Drawn or Administrative Officer _____

FAMU REQUISITION / CHANGE ORDER

Recommended Vendor
Radio Shack
1964 W. Tennessee Street
Tallahassee, FL 32304

Telephone No. 575-2355 FEID No. _____
* (If vendor is new)
Selected Vendor
Complete Address
Including Zip Code

Req. No. No 240536 Requisition Change Order
DELIVER TO: (COMPLETION IS MANDATORY)
Building College of Engineering
Room Number 131

CHECK ONE:
☒ EXPENSE
☐ REG. OCO
☐ OPS CONT. SER.
☐ SC/TECH.OCO
☐ FIXED CAP. CONST.
☐ CARRY FORWARD
☐ BDP CAT.
☐ SPECIAL CATEGORY

For Purchasing use only

Line No. (7-9)	Sub Line (10-11)	Description (Enter Double Space) (12-33)	P.O. No. Change Code (34-39)	Department Number (43-51)	Object Code (52-56)	Avl Bal (57)	Quantity (58-62)	Unit (63-66)	Unit Price (67-76)	Disc. % (77-79)	Extended Total
1		Hookup Wire, 12 gauge, Red, #278-565		190800001			1 ea	ea	3.99		3.99
2.		Hookup Wire, 12 gauge, Black, #278-566					1	ea	3.99		3.99
3.		Hookup Wire, 18 gauge solid, 3 spools, #278-1223					1	ea	3.99 4.49		3.99 4.49
4.		Hookup Wire, 18 gauge stranded, 3 spools					1	ea	4.49		4.49
5.		Phone extension cord, 25 ft., #279-363					1	ea	6.49		6.49
6.		8 piece ball end hex key set, #64-1817					1	ea	8.99		8.99
7.		Thin long nose pliers, #64-1931					1	ea	6.99		6.99
8.		Diagonal wire cutters, #64-1930					1	ea	6.99		6.99
9.		Automatic wire stripper, #64-1919					1	ea	11.99		11.99
10.		Electrician's pliers, #64-1871					1	ea	4.99		4.99
11.		Hi-impact nut driver XXXX set, #64-1800					1	ea	7.49		7.49
12.		Mini-precision screw driver set, # 64-1962					1	ea	4.49		4.49
13.		5 1/2" XXXXXX Locking forceps, #64-1940					1	ea	4.79		4.79
14.		Solderless spade tongues, #64-3031					2	ea	1.39		2.78

Phone 487-6151

Enter Person's Name for Contact if help is needed Brian
Enter Purchase Brief Justification

?									
Requisition/P.O. No. (1-6)	Memo Encumbrance (7-12)	Function (13)	Vendor Number (14-22)	Terms (23)	FOB (24)	Ship To (25)	Delivery Date (26-31)	Standard Statements (32-33) (34-35) (36-37)	Type (38)
Action (39)	Bid/Contract/Quote (40-48)	Attention To (49-55)	Agent (56)	Requested By (57-63)	Avl-Bal (64)		Requisition Date (65-70)	Job Number (71-77)	Blanket (78)
									NoPrint (79)
									Card (80)

DISTRIBUTION: WHITE - PURCHASING • YELLOW - PURCHASING • PINK - REAMENDED • GREEN - REQUESTED

CHASING DEPARTMENT
2. MOOTE-HILYER ADM. CTR.

FAMU REQUISITION / CHANGE ORDER

Department Chemical Engineering
Account No. 190800001
Date 1/19/95
Initiated by B. Scott 487-6151 Ext.
Approved by
Approved by
Dean or Administrative Officer

Recommended
Vendor
Complete Address
including Zip Code
Radio Shack
1964 W. Tennessee Street
Tallahassee, FL 32304

Telephone No. 575-2355 FEID No.
* (If vendor is new)

Selected
Vendor
Complete Address
including Zip Code

Req. No. No 240537 Requisition
☐ Change Order

DELIVER TO: (COMPLETION IS MANDATORY)

Building College of Engineering
Room Number 131

CHECK ONE:

- ☒ EXPENSE
☐ REG. OCO
☐ OPS CONT. SER.
☐ SC/TECH.OCO
☐ FIXED CAP. CONST.
☐ CARRY FORWARD
☐ EDP CAT.
☐ SPECIAL CATEGORY

For Purchasing use only

Line No. (7-9)	Sub Line (10-11)	Description (Enter Double Space) (12-33)	P.O. No. Change Code (34-39)	Department Number (43-51)	Object Code (52-56)	Avl Bal (57)	Quantity (58-62)	Unit (63-66)	Unit Price (67-76)	Disc. % (77-79)	Extended Total
15.		Solderless Flanged spades, #64-3043		190800001			X 2	ea	1.39		2.78
16.		Wire tap-ins, #64-3052					2	ea	1.39		2.78
17.		Locking forceps, #64-1866					1	ea	4.99		4.99
18.		Dual wattage soldering pencil, #64-2055					1	ea	9.49		9.49
19.		Soldering Iron Holder, #64-2078					1	ea	6.49		6.49
20.		Rosin core solder, .062", 4 oz., #64-004					2	ea	3.79		7.58
21.		Rosin core solder, .032", 2.5 oz., 64-005					1	ea	3.49		3.49
22.		High strength electrical tape, #64-2352					1	ea	3.49		3.49
23.		Cable ties, 8" long, #278-1652					2	ea	2.99		5.98
24.		Cable ties, 14½" long, #278-1655					2 ea	ea	4.99		9.98
25.		One minute epoxy glue, #64-2328					1	ea	3.99		3.99
26.		Instant Bonding glue, # 64-2308					2	ea	1.79		3.58
27.		Silicon rubber sealant, #64-2314					1	ea	2.99		2.99
28.		Household lube gel, #64-2326					1	ea	2.99		2.99
29.		Clamp-on AC ammeter, #22-161 Phone <u>487-6151</u> Enter Person's Name for Contact if help is needed <u>Brian</u> Enter Purchase Brief Justification					1	ea	49.99		49.99

Requisition/P.O. No. (1-6)	Memo Encumbrance (7-12)	Function (13)	Vendor Number (14-22)	Terms (23)	FOB (24)	Ship To (25)	Delivery Date (26-31)	Standard Statements (32-33) (34-35) (36-37)	Type (38)	
Action (39)	Bid/Contract/Quote (40-48)	Attention To (49-55)	Agent (56)	Requested By (57-63)	Avl-Bal (64)	Requisition Date (65-70)	Job Number (71-77)	Blanket (78)	No/Print (79)	Card (80)

Department Chemical Engineering

FAMU REQUISITION / CHANGE ORDER

Requisition No 240538 ☐ Change Order

Recommended Vendor
Radio Shack
1964 W. Tennessee Street
Tallahassee, FL 32304

Telephone No. 575-2355 * (If vendor is new)
FEID No. _____

Selected Vendor
Complete Address including Zip Code

Building College of Engineering
Room Number 131

CHECK ONE:
☒ EXPENSE
☐ REG. OCO
☐ OPS CONT. SER.
☐ SC/TECH.OCO

☐ FIXED CAP. CONST.
☐ CARRY FORWARD
☐ EDP CAT.
☐ SPECIAL CATEGORY

For Purchasing use only

Line No. (7-9)	Sub Line (10-11)	Description (Enter Double Space) (12-33)	P.O. No. Change Code (34-39)	Department Number (43-51)	Object Code (52-56)	Avl Bal (57)	Quantity (58-62)	Unit (63-66)	Unit Price (67-76)	Disc. % (77-79)	Extended Total
30.		8-ohm non-inductive resistor, #271-120		190800001			20	ea	1.49		29.80
31.		120 volt neon lamp, red, #272-712					1	ea	2.19		2.19
32.		120 volt neon lamp, amber, #273-707					1	ea	1.99		1.99
33.		120 volt neon lamp, green, #272-708					1	ea	2.59		2.59
34.		Lighted 125 VAC SPST Switch, #275-671					1	ea	3.99		3.99
35.		Metal cabinet, 3" x 5 1/2" x 5 7/8"					2	ea	6.99		13.98
36.		Six outlet surge protector, #61-2121					1	ea	34.99		34.99
37.		Krypton focusing flashlight, #61-2541					1	ea	6.49		6.49
38.		Dual timer /clock, # 63-894					1	ea	17.99		17.99
39.		Batteries, Alkaline, AAA size, #23-558					1	ea	2.99		2.99
40.		Batteries, Alkaline, AA size, #23-552XXX					1	ea	2.99		2.99
41.		Batteries, Alkaline, D size, #23-650					1	ea	7.99		7.99
42.		Batteries, Alkaline, 9V Rectangular size #23-653					1	ea	6.99		6.99
											338.51

Requisition/P.O. No. (1-6)	Memo Encumbrance (7-12)	Function (13)	Vendor Number (14-22)	Terms (23)	FOB (24)	Ship To (25)	Delivery Date (26-31)	Standard Statements (32-33)	Type (38)
Action (39)	Bid/Contract/Quote (40-48)	Attention To (49-55)	Agent (56)	Requested By (57-63)	Avl-Bal (64)	Requisition Date (65-70)	Blanket (78)	Job Number (71-77)	Not'Print Card (80)

GENERAL REQUISITION

FLORIDA STATE UNIVERSITY

INSTRUCTIONS

1. Prepare in triplicate. Forward first two copies to Purchasing Department. Second copy will be returned with requisition number for your file. The number assigned to this requisition should be referenced if it is necessary to contact the Purchasing Department concerning this requisition. Describe each item completely, specifying the noun first. Double space between items. When an item is for specialized use, give details of how it will be used and for what purpose. Requisitions received without departmental information and/or complete item description will be returned. For further information see Section 2, Subject 1.1 of the University Business Manual.

Organization Code	EQ	Object Code	Date
Please ask Bruce.			1-19-95
Item Required	Location for Delivery		
ASAP	Pick-up		
Individual's name initiating request			
W.C. Finney			
Approved for Dept.			
Telephone No. 487-6309			
Dean or Division Head			

EMERGENCY SERVICE ONLY

If emergency service is necessary the department head or principal investigator must sign below.

☐ Process on a rush basis and expedite mailing purchase order to vendor.

☐ Telephone order to vendor and charge call to the following number: _____

(DO NOT WRITE IN THIS SPACE)

Requisition Number _____

Date Received _____

Purchase Order Number _____

Signature of department head or P.I.

Item No.	DEPARTMENT NOTE Item Description: Give complete specifications including size, color, grade, catalog or part number and brand name.	ONLY TYPE OR PRINT (SPECIFY NOUN FIRST)	DOUBLE SPACE BETWEEN ALL ITEMS	Object Code	Quantity & Unit	Unit Price	Disc. %	Extended TOTAL	Recommended Vendor, (s)
1.	Fabrication of Large Aluminum Box to be used as an electromagnetic noise shield for a pulsed power supply.				1 ea	\$134.08	\$	134.08	List complete address (Do not use acronyms or abbreviations) including zip, phone and Federal Employer Identification Number (FEID) or Social Security Number (SS) if an individual.
	Includes:								FEID/SS
	1. Shearing of four three 4 ft x 3 ft x 1/16" thick aluminum panels. Material supplied by us.								Minority Classification (For New Vendors)
	2. Shearing of two 3 ft x 3 ft x 1/16" thick aluminum panels. Material supplied by us.								<input type="checkbox"/> See back of pink copy for codes
	3. Shearing of two 2 ft x 3 ft x 1/8" thick aluminum panels. Material supplied by Tallahassee Welding.								Vendor
	4. Attachment of two side panels, top panel, bottom panel, and back panel to 4 ft x 3 ft x 3 ft aluminum L-angle frame, which is supplied by us.								Tallahassee Welding
	5. Return of balance (drop) of two 4 ft x 12 ft long x 1/16" thick sheets of aluminum, which were supplied by us.								\$ Machine Shop, Inc.
									1220 Lake Bradford Rd.
									Tallahassee, FL
									32304
									(904) 576-9596

THIS SPACE FOR USE OF PURCHASING ONLY

Req. No.	Vendor F.E.I.D. No.	Term	FOB	Del. Date	STD 1	STD 2	STD 3	Type
SA	Bid, Cont., Quote	Attn. To	Agent No.	Req. By	Req. Date	Job No.	Print Ind.	

TURNER SUPPLY COMPANY

MOBILE, ALA. - DOTHAN, ALA. - THOMASVILLE, ALA. - PENSACOLA, FLA.
TALLAHASSEE, FLA. - PASCAGOULA / MOSS POINT, MISS. - LAUREL, MISS.

PAGE 1

2729200
FLORIDA STATE UNIVERSITY
CONTROLLERS OFFICE
FED ID #63-0213410
ACCTS PAYABLE SECTION
TALLAHASSEE, FL 32306-1027

2729200

FLORIDA STATE UNIVERSITY

CONTROLLERS OFFICE

FED ID #63-0213410

ACCTS PAYABLE SECTION

TALLAHASSEE, FL 32306-1027

MARK ORDER

MERCHANDISE CANNOT BE RETURNED WITHOUT OUR PERMISSION.

PICK TICKET

0 007

0564335-001

PO NO.	ORDERED	ITEM NUMBER	DESCRIPTION	QUANTITY SHIPPED	UNIT	UNIT PRICE	EXTENSION
		724840234	41-10234 LIST 236 JOBBERS DRILL	1	EA	71.00	.71
		724840221	41-10221 LIST 236 JOBBERS DRILL	1	EA	69.00	.69
		101210150	15/8X1-1/2 GR 5 ZINC PLT NC HEX BOLT	22	EA	9.00	19.80
		101220010	5/8" GR 2 ZINC PLT NC NUT	22	EA	25.00	5.50
		101220110	5/8" PLT FLAT WASHER	50	EA	22.00	11.00
SUBTOTAL							37.70
TAX							
DEPOSIT							
TOTAL							37.70

MERCHANDISE LISTED HEREON IS RECEIVED IN GOOD CONDITION.

VPANY:

RECEIVED BY:

McCurry

DATE RECEIVED:

12-28-94

ALL SALES SUBJECT TO STANDARD CONDITIONS OF SALE OUTLINED ON REVERSE SIDE OF THIS FORM.

STORE HOURS

8:00 AM TO 5:00 PM

MONDAY THRU FRIDAY

MOBILE

250 NORTH ROYAL STREET

MOBILE, AL 36602

PHONE 205/438-5581

WATS 800/825-5581

FAX 205/432-3216

DOTHAN BRANCH

2002 ROSS CLARK CIRCLE

DOTHAN, AL 36301

PHONE 205/793-2647

WATS 800/695-3488

FAX 205/793-5145

PENSACOLA BRANCH

2410 NINE MILE ROAD

PENSACOLA, FL 32533

PHONE 904/477-1360

WATS 800/477-1360

FAX 904/477-1362

PASCAGOULA-MOSS POINT BRANCH

7030 GRIERSON STREET

MOSS POINT, MS 39563

PHONE 601/475-2287

FAX 601-475-2374

LAUREL BRANCH

1457 WEST DRIVE

LAUREL, MS 39440

PHONE 601/425-1451

WATS 800/456-1451

FAX 601/649-8418

THOMASVILLE BRANCH

2500 JOE DAVIS INDUSTRIAL BLVD.

THOMASVILLE, AL 36784

PHONE 205/636-9711

WATS 800/289-9711

FAX 205/636-8273

TALLAHASSEE BRANCH

905 WEST GAINES ST.

TALLAHASSEE, FL 32304

PHONE 904/425-4601

FAX 904/425-4604



DEPARTMENT OF THE AIR FORCE
ARMSTRONG LABORATORY (AFMC)
TYNDALL AIR FORCE BASE, FLORIDA

MEMORANDUM FOR RECORD

27 Jul 94

FROM: AL/EQS (Mr Alan Canfield, ASI, 283-6198)

SUBJECT: FSU Receipt of Supplies for Contract F086379-94-M-6015

Please see attached Memorandum for Record from TSgt Junn dated 27 Jul 94 listing equipment and materials received by Florida State University under the above referenced contract. These items will be used only toward design and construction of a pulsed streamer corona reactor and supporting equipment as outlined in the statement of work.

RECEIVED BY:

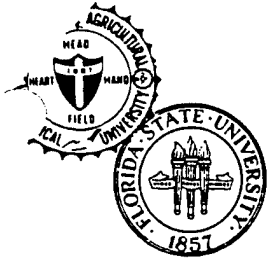
Bruce R. Locke

DATE RECEIVED:

7-27-94

PRINT NAME: Bruce R. Locke

PHONE #: 904-487-6165



FAMU/FSU COLLEGE OF ENGINEERING

Department of
Chemical Engineering
P.O. Box 2175
Tallahassee, Florida
32316-2175

Telephone (904) 487-6149
FAX Number (904) 487-6150

Glenn 1/3 8/4 1994
FOLSOM SHEET METAL WORKS
Worker Ellis 1/3 Hrs. \$

Job Item PO # 420800240
For Defense Contracting Supply Corp.

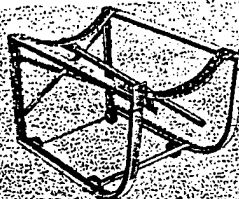
QUANTITY	ITEM	AMOUNT
110 ft	16 oz copper - 6" wide	197 00
110 ft	16 oz copper - 3" wide	103 50
		300 50

Paid by Check # 000 1168

DRUM EQUIPMENT

MATERIAL HANDLING

55-GALLON DRUM CRADLES

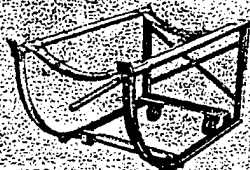


No. 2W472

WESCO
MANUFACTURING COMPANY



No. 4W458



For manually handling 55-gallon drums. Simplifies storage, loading and unloading, and on-the-job dispensing operations. Four easy steps enable one operator to handle fully loaded drums: (1) Position cradle next to drum (2) Hook tipping lever on drum chime (3) Tip load on the curved rails (4) Move loaded cradle on its wheels to new location. Cradle frame is box channeled steel, cross-braced for rigidity. Nonsparking, oil and chemical-resistant wheels standard on both models. Load capacity 600 lbs, drain height 15". 32 1/2" L x 19 1/2" W. Orange color. Shipped unassembled. Wesco Mfg. Brand.

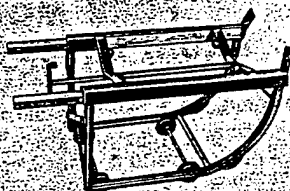
No. 2W472 has four 2 1/2" rigid polyolefin wheels mounted inside the frame.

No. 4W458 has two 2 1/2" rigid polyolefin wheels and two 3" polyolefin swivel casters for easy steering.

Wheels	Casters	Wesco Mfg. Model	Stock No.	List	Each	Lots 3	Shpg. Wt.
4	—	CW-10	2W472	\$93.00	\$75.70	\$71.89	30.0
2	2	CWS-10	4W458	124.50	92.40	87.76	37.0

30 AND 55-GALLON INDUSTRIAL DRUM CRADLE

WESCO
MANUFACTURING COMPANY



Drum cradle enables one operator to tip, move, rotate, drain, and store industrial drums weighing up to 1000 lbs. Handles either 30 or 55-gallon metal industrial drums with ease. Two hardwood retractable handles extend from 42 to 64", giving operator leverage and safety when tipping drum down for draining. Horizontal position is 20" above floor surface. Polyolefin rollers enable drum to be rotated for positioning. Drum hook and beveled toes are made of long wearing carbon steel. Cradle moves on four 4" polyolefin wheels that resist reaction with fats, oil, and chemicals. Unit comes partially assembled. Top section has welded steel construction that bolts to the uprights. 25 1/2" H x 19" W. Orange. Wesco Mfg brand (CW-20).

No. 3W399. Shpg. wt. 54.0 lbs. List \$179.60. Each \$132.20

DRUM DOLLIES

- Four models fit standard 30, 45, and 55-gallon steel or plastic drums and support 500, 840, and 1400 lb loads.

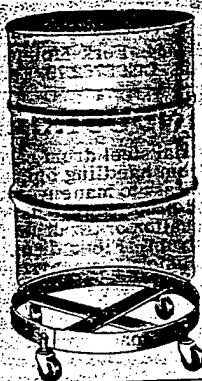
Wagner

Nos. 2W269, 3W039, & 3W040

Rubbermaid



No. 5W562



PARTS AVAILABLE.
CALL
1-800-323-0620

Add mobility to heavy industrial drums and enable reusable drums to serve as convenient containers for scrap metal, liquids, parts, and refuse.

No. 5W562 is of structural foam which will not rust or bend, has a solid bottom, and comes with five heavy-duty casters. Nos. 2W269, 3W039, and 3W040 have a circular frame of welded steel, with cross-bracing on the bottom, and four heavy-duty duo-level ball bearing swivel casters. Rubbermaid and Wagner brands.

SPECIFICATIONS

Dolly Capacity	Dolly Size Dia	Dolly Size In. Dia	Ht	Caster	
				Size	Type
500 lbs	24 1/2"	23 1/2"	7 1/2"	3 x 1 1/4"	Rubber/Steel Plate
840	20 1/2"	19 1/2"	6 1/4"	3 x 1 1/4"	Molded Plastic
840	23 1/2"	23 1/2"	6 1/4"	3 x 1 1/4"	Molded Plastic
1400	23 1/2"	23 1/2"	6 1/2"	3 x 1 3/4"	Phenolic Resin

DRUM DOLLY ORDERING DATA

Dolly Capacity	For Drum Size	Mfr's. Model	Stock No.	List	Each	Lots 3	Shpg. Wt.
500 lbs	Up to 55 gal.	2650*	5W562	\$78.12	\$63.95	\$60.72	17.0
840	30	4866†	2W269	51.19	46.10	42.11	14.0
840	45, 55	4000†	3W039	57.05	51.40	46.92	19.0
1400	45, 55	4001†	3W040	92.17	83.05	75.81	20.0

(*) Rubbermaid brand. (†) Wagner brand.

PAIL DOLLY

For use with 5, 6, and tapered 15 gallon pails. Dual wheel swivel stem casters. Designed for industrial, commercial, or household use with items such as cooking products, cleaning agents, paints, construction compounds, and lubricants. Dishwasher safe for cleaning. Inside diameter is 11", overall diameter is 16". Beige color. Nameco brand (NAM-515).

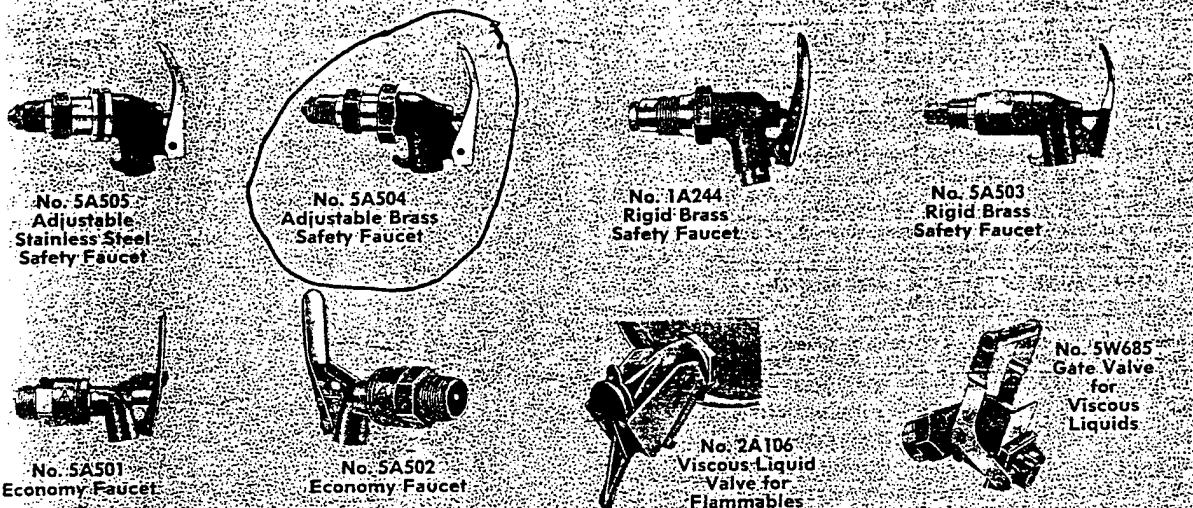
No. 6W061. Shpg. wt. 2.0 lbs. List \$25.44. Each \$24.68

SEE WARRANTY INFORMATION ON PAGE OPPOSITE INSIDE BACK COVER

1377

DRUM ACCESSORIES

MATERIAL HANDLING



No. 5A505
Adjustable
Stainless Steel
Safety Faucet

No. 5A504
Adjustable Brass
Safety Faucet

No. 1A244
Rigid Brass
Safety Faucet

No. 5A503
Rigid Brass
Safety Faucet

No. 5A501
Economy Faucet

No. 5A502
Economy Faucet

No. 2A106
Viscous Liquid
Valve for
Flammables

No. 5W685
Gate Valve
for
Viscous
Liquids

ADJUSTABLE STAINLESS STEEL SAFETY FAUCET

Single acting stainless steel faucet can be used with up to 30W and other flammables, as well as nonflammables compatible with SS construction. Faucet fits 3/4" NPS (19mm) bung in steel or plastic drums. Features include internal flame arrestor, Teflon seal. Adjustable feature allows nozzle to be positioned after faucet is threaded into drum without thread damage or leaking. For use with drum in horizontal position. FM approved. Wesco International brand (272038).

No. 5A505. Adjustable Stainless Steel Safety Faucet. Shpg. wt. 20 lbs. List \$147.10. Each \$105.10

ADJUSTABLE BRASS SAFETY FAUCET

Self-closing brass faucet can be tightly threaded into drum so nozzle can be adjusted to dispensing position without thread damage or leaking. Features include Teflon seal, internal flame arrestor. Use with oils up to 30W, noncorrosive flammables and nonflammables. Shank will fit 3/4" NPS (19mm) bung in steel or plastic drums. For use with drum in horizontal position. FM approved. Wesco International brand (272037).

No. 5A504. Adjustable Brass Safety Faucet. Shpg. wt. 2.0 lbs. List \$50.30. Each \$47.90

RIGID BRASS SAFETY FAUCET

Industrial duty 3/4" self-closing rigid faucet designed for safely dispensing flammable liquids from 30 and 55-gallon drums. Hand pressure on spring-loaded lever opens valve, releasing liquid. Pressure closes valve liquid-tight. Teflon O-ring valve seal. Perforated metal flash arrestor. Cast brass body. Fits 3/4" NPT bung opening. Drum must be stored horizontally for gravity flow dispensing. Factory Mutual System approved. Protective brand (531G).

No. 1A244. Rigid Brass Safety Faucet. Shpg. wt. 1.1 lbs. List \$43.05. Each \$43.05

RIGID BRASS SAFETY FAUCET

Heavy duty brass rigid self-closing faucet can be used with oils up to 30W, noncorrosive flammables and nonflammables. Features external flame arrestor, Teflon O-ring seal rigid shank

with 3/4" NPS (19mm) bung. For use with drum in horizontal position. FM approved. Wesco International brand (272081).

No. 5A503. Rigid Brass Safety Faucet. Shpg. wt. 1.4 lbs. List \$39.40. Each \$38.05

ECONOMY FAUCETS

Brass plated zinc die cast faucets are self-closing. Designed with nylon seal and padlock hole. Cannot be used with chlorinated solvents. Rigid shank fits 3/4" NPS (19mm) drum bung in steel or plastic drums. Model 5A501 is FM approved for viscous liquids only. Model 5A502 is supplied with flame arrestor and is FM approved; can be used with flammable or nonflammable liquids. Wesco International brand (272080 & 272083).

No. 5A501. Shpg. wt. 0.4 lbs. List \$9.10. Each \$8.91
No. 5A502. Shpg. wt. 0.4 lbs. List \$24.50. Each \$23.77

VISCOUS LIQUID VALVE FOR FLAMMABLES

Covers Opening and Seals Out Contaminants

Self-closing valve specifically designed for handling viscous flammables such as rubber cement, oils, oven-dry paints, etc. Full-floating metal shoe covers the 1 1/4" diameter opening and provides a reliable seal. Self-closing feature cuts off flow to prevent spillage. Wire safety guard. Built-in lock tab. Valve body is gray iron, shoe is red brass. 2" NPT. Factory Mutual approved. Protectoseal brand (545A).

No. 2A106. Viscous Liquid Valve. Shpg. wt. 4.9 lbs. List \$132.89. Each \$126.60

GATE VALVE FOR VISCOUS LIQUIDS

Self-closing brass safety gate valve is designed for use with viscous noncorrosive liquids heavier than 30W motor oil (2000 SSU). Wide mouth opening permits maximum flow. Knife style spring activated Teflon blade has fast positive shut off when handle is released. 4 1/2" wide handle provides easier opening and more precise control. Fits 2" NPS (51mm) bung in steel or plastic drums. For use with drum in horizontal position. FM approved. Wesco International brand (272034).

No. 5W685. Gate Valve. Shpg. wt. 6.9 lbs. List \$111.60.
Each \$106.30

SEE WARRANTY INFORMATION ON PAGE OPPOSITE INSIDE BACK COVER

1383

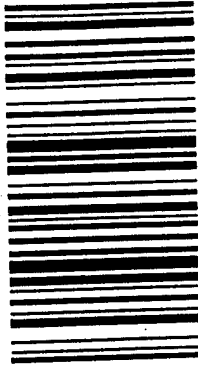


UPS SHIPPER NO
IL 610-X40
PKG ID # 8526-400
12/08/94

UPS DeliveryTracSM



IDENTIFICATION NUMBER



8021 5478 661

UPS DeliveryTracSM

1/94 MS

J. E. HAILEY CO. (708) 852-6400

5111 CHASE AVENUE

DOWNERS GROVE, IL 60515

GILES NATIONAL SUPPORT SYSTEMS

TO

FLORIDA STATE UNIVERSITY
2525 POTSHAMMER RD
TALLAHASSEE, FL 32316

ATTN: MR. FINNEY

RETURN POSTAGE GUARANTEED

Drum Dolly

WESCO®

044584

INTERNATIONAL INC.

P.O. BOX 47
LANSDALE, PA 19446
PHONE: (215) 699-7031 FAX: (215) 699-3836

SOLD TO

CREDIT CARD

SHIP TO

FLORIDA STATE UNIV
2525 POTS BAMMER ROAD
PO#S0863795P1100
TALLAHASSEE, FL

32316

SPECIAL INSTRUCTIONS

UFS

DATE
ORDER RECEIVED

12/07/94

SHIPPING DATE

12/12/94

CUSTOMER
PURCHASE ORDER NO.

FAX/GILES

CUSTOMER
NO.

984350

OTB: FAX

OER: EC

GILES

✓	QUANTITY ORDERED	QUANTITY SHIPPED	MODEL NUMBER	DESCRIPTION
	1		272037	CAST BRASS ADJUST. FAUCET WITH FILTER
				SHIP & HAND \$5.00

Drum Faucet

LIST ENCLOSED

FROM:
Wesco International
1560 INDUSTRY ROAD
HATFIELD, PA.
19440

TO:
FLORIDA STATE UNIV
2525 POTS BAMMER ROAD
PO#S0863795P1100
TALLAHASSEE, FL 32316

* UPS SHIPPER NO *
* PA 171-877 *
* PKG ID #W1044584 *

PACK 70 LIST

RECEIVING REPORT

FLORIDA STATE UNIVERSITY
WILDWOOD DRIVE
TALLAHASSEE, FLORIDA 32306-3047

INSTRUCTIONS:
Department should verify (or fill in) quantity received for each item, sign, and retain green copy. RETURN ALL OTHER COPIES TO RECEIVING DEPARTMENT (CODE 3047) WITHIN 24 HOURS. IF CONCEALED DAMAGES OR SHORTAGES ARE FOUND, RETAIN ALL PACKAGING MATERIALS ALONG WITH CONTENTS AND PACKING LIST AND NOTIFY RECEIVING (4-2750) WITHIN 24 HOURS AFTER SHIPMENT IS DELIVERED TO YOUR DEPARTMENT. Failure to follow these instructions may result in your loss of ability to file a claim for the loss or damage.

Purchase Order No.
620531
THIS NUMBER MUST APPEAR ON ALL CORRESPONDENCE, SHIPMENTS AND INVOICES.
☐ CHANGE ORDER
NUMBER _____
TO THE ABOVE ORDER

Telephone No. 644-2750

Report No. 1

V
E
N
D
O
R

GRAYBAR ELECTRIC COMPANY
INC.
110 CENTURY PARK DR
TALLAHASSEE, FL 32302

RECEIVED

DEC 19 1994

DATE				
CTN./WT.				
VIA				
FRT. BILL NO.				

RECEIVING DEPARTMENT

EVERY DESIRED BY:	TERMS:	F.O.B.	QUOTE/BID/S.C. NO.
12/29/94	NET 30 DAYS	SHIPPING POINT	
OR SOONER			
DESCRIPTION	ORJ. CODE DEPT. NO.	QUANTITY AND UNIT	QUANTITY REC'D.

1 GROUND ROD, STEEL WITH COPPER CLADDING, 3/4" DIAMETER WITH THREADS FOR COUPLING, 10 FT LONG

399000
206110521
27

3.0000
EACH

2 COUPLING FOR ABOVE GROUND ROD SEGMENTS

399000
206110521
27

3.0000
EACH

3 DRIVE STUD FOR ABOVE GROUND ROD /JT

399000
206110521
27

2.0000
EACH

SHIP TO:
M.C. FINNEY
DEPARTMENT PICK-UP
F.S.U. 0000 SEE ABOVE
TALLAHASSEE FL 32306-2175
(904) 644-6151

EQ. NO. Q50260P	JOB NO.	INITIATED BY FINNEY,	BUYER 7	VENDOR NO. VF130794380003
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I certify that the quantities shown above were received in apparent good condition except as noted above.

I certify that the quantities shown above were received inspected and accepted by me or under my supervision, and that payment is authorized, except as noted above

M. Finney 2-7-95
DATE RECEIVED SIGNATURE - DEPARTMENT REPRESENTATIVE

91KDXVUI



HOWARD VOLLUM PARK
P.O. BOX 500
BEAVERTON, OREGON 97075

Tektronix

CUSTOMER NO.

50000196

CUSTOMER P.O. NO.

F08637-94-F-B554

BUYER'S NAME

WARREN

REFERENCE NUMBER

91-KDXV-01

PLEASE USE THIS REFERENCE
NUMBER IN ALL COMMUNICATIONS

DATE 11/22/94		QUOTATION/CONTRACT GSF1005B		DATE SHIPPED	
TERMS-SUBJECT TO CREDIT APPROVAL NET 30 DAYS				PARTIALS NO	
DATE RELEASED 11/22/94	SHIP PROOF NO	COLL. NO	PREPAY CHARGE NO	INS. F.O.B. FACTORING NO	DE XXXXXXXXXX
CUSTOMER NUMBER 50000196	DESCRIPTION GSA	RESP. C.C.	SHIP VIA 4 / GSA		

SOLD TO

DEPT. OF THE AIR FORCE

DAO-DE TYN/FS

445 SUWANNEE ROAD SUITE 259

TYNDALL AIR FORCE BA FL 32403

MRK FOR: FIESCD 94FB554

SPECIAL SHIPPING INSTRUCTIONS

M/F ATTN: W.C. FINNEY

LINE NO.	QUANTITY SHIPPED	WT/LB	CTN. NO.	UNIT	STOCK NUMBER	OPT MOD	LOC.	DESCRIPTION
.00	1	38		EA	TDS460		0002	GSA# GS-24F-1005B
0001.00								OSCILLOSCOPE
.00	1	3		EA	TDS460 02	02		LINE ITEM 0001
.00								POUCH & COVER
.00								LINE ITEM 0002
.00								GSA REDUCTION
SHIPPED COMPLETE								

13021824

INSPECT THIS SHIPMENT AT ONCE! IF DAMAGED, REQUEST CARRIER INSPECTION IN WRITING WITHIN 15 DAYS AFTER DELIVERY. WE WILL NOT GIVE CREDIT FOR MERCHANDISE DAMAGED IN SHIPMENT WITHOUT A COPY OF INSPECTION REPORT. IF THERE IS A SHORTAGE CONTACT YOUR TEKTRONIX, INC. FIELD OFFICE.

PACKING LIST - IMPORTANT

W.C. FINNEY

611052127

11/1/94

Date Required

Location for Delivery

ASAP

Room 131, College of Engineering Bldg.

Individual's name initiating request

Telephone No.

W.C. Finney

(904) 487-6309

Approved for Dept

Dean of Division Head

W.C. Finney

Bruce L. Lohr

If emergency service is necessary the department head or principal investigator must sign below.

☐ Process on a rush basis and expedite mailing purchase order to vendor.
 ☐ Telephone order to vendor and charge call to the following number: _____

Signature of department head or P.I.

Item No.	DEPARTMENT NOTE Item Description: Give complete specifications including size, color, grade, catalog or part number and brand name.	ONLY TYPE OR PRINT (SPECIFY NOUN FIRST)	DOUBLE SPACE BETWEEN ALL ITEMS	Object Code	Quantity & Unit	Unit Price	Disc. %	Extended TOTAL	Recommended Vendor, (s)
1.	Swagelok Union, NY - 400 - 6 (1/4)				1 each	2.70		2.70	List complete address (Do not use acronyms or abbreviations) including zip, phone and Federal Employer Identification Number (FEID) or Social Security Number (SS) if an individual.
2.	Swagelok Union, NY - 500 - 6 (5/12)				1 each	3.20		3.20	
3.	Swagelok Union, NY - 600 - 6 (3/8)				1 each	4.20		4.20	
4.	Swagelok Reducing Union, NY - 500 - 6 - 4 (5/16 - 1/4)				1 each	5.10		5.10	
5.	Swagelok Reducing Union, NY - 600 - 6 - 5 (3/8 - 5/16)				1 each	11.30		11.30	
6.	Swagelok Reducing Union, NY - 600 - 6 - 4 (3/8 - 1/4)				1 each	4.20		4.20	
7.	Swagelok Ferrules, NY - 400 - Set (1/4)				10 each	.53		5.30	
8.	Swagelok Ferrules, NY - 500 - Set (5/16)				10 each	.60		6.00	
9.	Swagelok Ferrules, NY - 600 - Set (3/8)				10 each	.66		6.60	
					TOTAL:			48.60	

THIS SPACE FOR USE OF PURCHASING ONLY

Req. No.

Vendor F.E.I.D. No.

SA Bld, Cont., Quote

Attn. To

Req. By

Agent No.

Req. Date

Job No.

Del. Date

Print Ind.

Term FOB

STD 1 STD 2 STD 3 Type

SEND TO PURCHASING DEPT.

RECEIVING REPORT

FLORIDA STATE UNIVERSITY
WILDWOOD DRIVE
TALLAHASSEE, FLORIDA 32306-3047

INSTRUCTIONS:
Department should verify (or fill in) quantity received for each item, sign, and retain green copy. RETURN ALL OTHER COPIES TO RECEIVING DEPARTMENT (CODE 3047) WITHIN 24 HOURS. IF CONCEALED DAMAGES OR SHORTAGES ARE FOUND, RETAIN ALL PACKAGING MATERIALS ALONG WITH CONTENTS AND PACKING LIST AND NOTIFY RECEIVING (4-2750) WITHIN 24 HOURS AFTER SHIPMENT IS DELIVERED TO YOUR DEPARTMENT. Failure to follow these instructions may result in your loss of ability to file a claim for the loss or damage.

PURCHASE ORDER NO.
G17626
THIS NUMBER MUST APPEAR ON ALL CORRESPONDENCE, SHIPMENTS AND INVOICES.
☐ CHANGE ORDER
NUMBER _____
TO THE ABOVE ORDER

Telephone No. 644-2750 Report No. 2

V
E
N
D
O
R

JAX VALVE & FITTING CO.
3633 SOUTHSIDE BLVD.
PO BOX 16097
JACKSONVILLE, FL 32245

DATE	12/22			
CTN./WT.	1			
VIA	UP			
FRT. BILL NO.				

DELIVERY DESIRED BY: 11/17/94	TERMS: OR SOONER NET 30 DAYS	F.O.B.	QUOTE/BID/S.C. NO.
SHIPPING POINT		QUANTITY REC'D.	
DESCRIPTION	ORJ. CODE DEPT. NO.	QUANTITY AND UNIT	Shipment

THE FOLLOWING ARE SWAGELOK:

REDUCING UNION, NY - 600 - 6 - 5 -
(3/8 - 5/16)

399000
206110521
27

1.0000
EACH

SHIP TO:

FINNEY, W.
COLLEGE OF ENGINEERING
F.S.U. 131 ENGINEERING
TALLAHASSEE FL 32306-2175
(904) 644-6309

Q. NO. Q47176P	JOB NO.	INITIATED BY FINNEY,	BUYER 7	VENDOR NO. VF591565948002
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I certify that the quantities shown above were received in apparent good condition except as noted above.

I certify that the quantities shown above were received, inspected and accepted by me or under my supervision, and that payment is authorized, except as noted above.

DATE RECEIVED SIGNATURE - CENTRAL RECEIVING
FSU Form RR22 Rev. 12/93

DATE RECEIVED SIGNATURE - DEPARTMENT REPRESENTATIVE

Electronic Maintenance Supply Company
250 East First Street
Jacksonville, FL 32206
Tel. (904) 356-4851 or (800) 275-3029
FAX. (904) 358-8759

<u>Item</u>	<u>Description</u>	<u>Qty</u>	<u>Unit</u>	<u>Price (ea)</u>	<u>Total</u>
1.	Belden RG-8/U Shielded Coaxial Cable, 52 ohm impedance, #8237.	100 ft	spool	\$ 102.00	\$ 102.00

Total: \$ 102.00

Victoreen, Inc.
6000 Cochran Road
Cleveland, OH 44139-3395
Tel. (216) 248-9300, ext. 302
FAX. (216) 248-9301

<u>Item</u>	<u>Description</u>	<u>Qty</u>	<u>Unit</u>	<u>Price (ea)</u>	<u>Total</u>
1.	Power-MOX Resistors, 1000 kohm (1.0 Mohm), 75 watt, 60 kV, 5% tolerance, #MOX-J-04-100-4-J	5	each	\$ 89.20	\$ 446.00

Total: \$ 446.00

W. W. Grainger, Inc.
 3924 W. Pensacola St.
 Tallahassee, FL 32304-2838
 Tel. (904) 575-4137
 FAX. (904) 575-1764

<u>Item</u>	<u>Description</u>	<u>Qty</u>	<u>Unit</u>	<u>Price (ea)</u>	<u>Total</u>
1.	Browning Valueline machined ball bearing pillow blocks, prelubricated self-aligning, flange mount 4-bolt, VF4S series normal duty, 1" bore diameter, Stock #5X699.	2	each	\$ 29.80	\$ 59.60
2.	Lovejoy flexible coupling, 1" bore diameter, Style L095, #4X193.	4	each	6.54	26.16
3.	Lovejoy Buna-N spider for above coupling, #1X407.	3	each	3.13	9.39
4.	Dayton square axial fan, 3 1/8", 30 CFM, #5C115.	2	each	20.25	40.50
5.	Dayton square axial fan, 4 11/16", 110 CFM, #4C550.	2	each	21.52	43.04
6.	Axial fan cord set, #4C552.	4	each	1.46	5.84
7.	Plastic guard for 3 1/8" fan above, #5C035.	2	each	1.24	2.48
8.	Plastic guard for 4 11/16" fan above, #5C034.	2	each	1.66	3.32

Total: \$ 190.33

Small Parts, Inc.
13980 N.W. 58th Court
P.O. Box 4650
Miami Lakes, FL 33014-0650
Tel. (305) 558-1255
FAX. (800) 423-9009

<u>Item</u>	<u>Description</u>	<u>Qty</u>	<u>Unit</u>	<u>Price (ea)</u>	<u>Total</u>
1.	#Q-BNMX-16, Ball, Stainless Steel Type 316, 1 inch diameter.	4	each	\$ 6.42	\$ 25.68
2.	Custom braized or welded installation of 1/4-20 x 3" long stainless steel threaded stud perpendicular onto each of the above stainless steel balls (RE: # 1 above and conversation with "Ziggy" of 5-17-94).	4	each	27.50	110.00
3.	#Q-ZRXX-6-12, Round Bar, Stainless Steel Type 316, 3/8" diameter, 12" long.	1	each	5.17	5.17
4.	#Q-ZRXX-8-12, Round Bar, Stainless Steel Type 316, 1/2" diameter, 12" long.	1	each	5.24	5.24
5.	#Q-ZRD-16-24, Round Rod, Delrin, 1" diameter, 24" long.	1	each	17.01	17.01
6.	#Q-ZRD-24-24, Round Rod, Delrin, 1 1/2" diameter, 24" long.	1	each	36.06	36.06
7.	#Q-TRX-1420-24, Threaded Rod, Stainless Steel, 1/4-20 x 24" long.	1	each	8.72	8.72
8.	#Q-HSCD-0, Center Drill, High Speed Steel, Size 0.	4	each	5.90	23.60

Q	#Q-HSTW-6B, Tap Wrench, Starrett, 5 3/4" long.	1	each	36.43	36.43
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Total: **\$267.91**

Cole-Parmer, Inc.
 7425 N. Oak Park Ave.
 Niles, IL 60714-4340
 Tel. (800) 323-4340
 FAX. (708) 647-9660

<u>Item</u>	<u>Description</u>	<u>Qty</u>	<u>Unit</u>	<u>Price (ea)</u>	<u>Total</u>
1.	Digistrobe Microprocessor-controlled Stroboscope /Tachometer, #G-08191-00.	1	each	\$ 495.00	\$ 495.00
2.	Phase-shift kit for above stroboscope, #G-08191-50.	1	each	135.00	135.00
3.	Optical Sensor for above stroboscope, #G-08191-60.	1	each	80.00	80.00
4.	Swivel Stand for benchtop mounting of above stroboscope, #G-08191-70.	1	each	70.00	70.00
5.	High Density Polyethylene Box, 2 gallon, 18 x 12 x 3 1/2 in., #G-06017-10.	1	each	9.70	9.70
6.	High Density Polyethylene Box, 3 1/2 gallon, 18 x 12 x 6 in., #G-06017-12.	1	each	11.40	11.40
7.	High Density Polyethylene Box, 5 gallon, 18 x 12 x 9 in., #G-06017-14.	2	each	16.80	33.60
8.	High Density Polyethylene Box, 8 1/2 gallon, 18 x 26 x 6 in., #G-06017-16.	1	each	19.70	19.70
9.	High Density Polyethylene Top (for Item # 7 above), #G-06017-21.	4	each	7.50	30.00
10.	High Density Polyethylene Top (for Item # 8 above),	1	each	10.80	10.80

#G-06017-22.

Total: **\$ 895.20**

Cableform-Beman
Zion Cross Roads
Troy, VA 22974
Tel. (804) 589-8224
FAX. (804)589-3803

<u>Item</u>	<u>Description</u>	<u>Qty</u>	<u>Unit</u>	<u>Price (ea)</u>	<u>Total</u>
1.	#CJF-B-1-15-1MEG, Carbon Film Resistors, 1 Megohm resistance (+/- 15%), 125 kV, 100 watts, with banded ends.	10	each	\$ 80.00	\$ 800.00

Total: \$ 800.00

Milgray Electronics
755 Rinehart Rd.
Lake Mary, FL 32746
Tel. (407) 321-2555

<u>Item</u>	<u>Description</u>	<u>Qty</u>	<u>Unit</u>	<u>Price (ea)</u>	<u>Total</u>
1.	Murata-Erie High Voltage Ceramic Capacitors, DHS Series, 2000 pF capacitance, 40 kV DC rated voltage, #DHS60-N4700-202M-40kV, (Note: 25 piece minimum order).	25	each	\$ 48.50	\$ 1212.50

Total: \$ 1212.50

OSCILLOSCOPES -- TEKTRONIX 1993 CATALOG

(12-9-93)

Specifications on new oscilloscope system for measuring voltage and current from the rotating spark gap pulsed power supply (40 - 60 kV peak voltage, 1 - 25 mA maximum current, 100 - 2000 ns pulse width, 10 - 50 ns rise time, 60 Hz frequency).

<u>Model Number</u>	<u>Description</u>	<u>Estimated Cost</u>
Scopes:		
TDS 420	Digitizing Storage Oscilloscope, 150 MHz bandwidth	\$ 5,995
<u>or</u>		
TDS 460	Digitizing Storage Oscilloscope, 350 MHz bandwidth	7,495
Options:		
Option 02	Front Cover and Accessories Pouch	60
Option 1M	60.000 Point Record Length	995
Option 13	RS232 and Centronics Type Hardcopy Interfaces	495
Option 1P	HC100 4-Pen Color Plotter	1,260
Option 1K	K212 Scope Cart	395
Probes:		
P6015A	High Voltage, 20 kV DC, 40 kV Peak Pulse, 1000x	950
AM503S	Current Probe System, DC to 15 MHz AC, 500 A peak pulse (Includes: AM503A Amplifier, TM502A Power Module, A6303 Current Probe)	3,395
		<hr/>
Total:	(For 420 Scope, Options 02 & 1P, HV Probe, Current Probe System)	\$11,660

To be obtained from:

<u>Purchase</u>	Tektronix, Inc. Test and Measurement Products 1101 Gulf Breeze Parkway Suite 211 Gulf Breeze, FL 32561	(904) 932-4080 (800) 628-6408
<u>Rental</u>	Leasametric 1164A Triton Drive Foster City, CA 94404	(415) 574-4441 (800) 553-2255
	GE Rental/Lease (Call for location)	(800) 437-3687

Hipotronics, Inc.
P.O. Drawer 414
Route 22
Brewster, NY 10509-0414
Tel. (914) 279-8091
FAX. (914) 279-2467

<u>Item</u>	<u>Description</u>	<u>Qty</u>	<u>Unit</u>	<u>Price (ea)</u>	<u>Total</u>
1.	High Voltage DC Power Pack, # 30C, 0 - 30 kV DC, 10 mA rated current.	1	each	\$ 590.00	\$ 590.00

Total: \$ 590.00

Universal Voltronics Corporation
27 Radio Circle Drive
Mount Kisco, NY 10549
Tel. (914) 241-1300

<u>Item</u>	<u>Description</u>	<u>Qty</u>	<u>Unit</u>	<u>Price (ea)</u>	<u>Total</u>
1.	High Voltage DC Power Supply, #BAL-130-28, 0 - 130 kV DC voltage, 28 mA rated current.	1	each	22,650.00	22,650.00

Total: \$ 22,650.00

Shell Petroleum Products
Rainey Cawthon, Distributor
601 W. Madison Street
Tallahassee, FL 32304
Tel. (904) 222-1948

<u>Item</u>	<u>Description</u>	<u>Qty</u>	<u>Unit</u>	<u>Price (ea)</u>	<u>Total</u>
1.	Shell "Dialax" Transformer Oil, PCP-free.	1	55 gal. drum	\$ 182.60	\$ 182.60

Total: \$ 182.50

Weico Wire and Cable
Attn: "Cindy Urso"
161 Rodeo Drive
Edgewood, NY 11717
Tel. (516) 254-2970
FAX. (516) 254-2099

<u>Item</u>	<u>Description</u>	<u>Qty</u>	<u>Unit</u>	<u>Price (ea)</u>	<u>Total</u>
1.	Tubular Braid, Tinned Copper	1	100 ft put-up	\$ 126.80	\$ 126.80

Total: \$ 126.80

Electronic Maintenance Supply Company
250 East First Street
Jacksonville, FL 32206
Tel. (800) 275-3029
FAX. (904) 358-8759

<u>Item</u>	<u>Description</u>	<u>Qty</u>	<u>Unit</u>	<u>Price (ea)</u>	<u>Total</u>
1.	Tripp-Lite Line Conditioner with Isolation, Load-to-Load = 2400 watts, # LC-2400.	1	each	\$ 399.00	\$ 399.00
Total					\$ 399.00

J. M. Tull Metals Co.
Attn: "Ted"
5336 Highway Avenue
P.O. Box 6518
Jacksonville, FL 32205
Tel. (800) 551-8855 or (904) 783-8855
FAX. (904) 781-9106

<u>Item</u>	<u>Description</u>	<u>Qty</u>	<u>Unit</u>	<u>Price (ea)</u>	<u>Total</u>
1.	Aluminum Flat Sheet, 6061-T6 Alloy, 0.063" thick (1/16") x 48" wide x 144" long.	2	Sheets	\$ 131.36	\$ 131.36
2.	Aluminum Extruded L-Angle, 6063-T5 Alloy, 0.125" thick x 1" x 1".	3	16 ft. lengths	13.27	39.81
3.	Stainless Steel Pipe, 4", Type # 316L, Schedule 5.	1	11 ft drop	227.20	227.20
4.	Stainless Steel Pipe, 2", Type # 316L, Schedule 5.	1	10 ft drop	126.40	126.40
Total				\$ 656.13	

Commercial Plastics Service Center
2331 Laura Street
Jacksonville, FL 32206
Tel. (904) 354-2000 or (800) 342-8484
FAX. (904)

<u>Item</u>	<u>Description</u>	<u>Qty</u>	<u>Unit</u>	<u>Price (ea)</u>	<u>Total</u>
1.	Plexiglass Sheet, Type G, Clear, 0.500" thick x 4 ft wide x 8 ft long.	1	each	\$ 194.88	\$ 194.88
2.	Plexiglass Sheet, Type G, Clear, 0.250" thick x 4 ft wide x 8 ft long.	1	each	68.16	68.16

Total: \$ 263.04

C & H Sales Company
2176 E. Colorado Blvd.
Pasadena, CA 91107
Tel. (800) 325-9465 or (213) 681-4925
FAX. (818) 796-4875

<u>Item</u>	<u>Description</u>	<u>Qty</u>	<u>Unit</u>	<u>Price (ea)</u>	<u>Total</u>
1.	Reliance Motor, 1/4 HP, 1800 rpm, AC Synchronous, Reversible, # G78B3263M-TQ.	1	each	\$ 69.50	\$ 69.50

Total: \$ 69.50

Alloy Piping Supply, Inc.
 Attn: Scott Burch
 P.O. Box 26887
 Jacksonville, FL 32226-6687
 Tel. (800) 342-0248
 FAX. (904) 356-5447

<u>Item</u>	<u>Description</u>	<u>Qty</u>	<u>Unit</u>	<u>Price (ea)</u>	<u>Total</u>
1.	Welding Neck Flange, Part No. 111, Ideal IPS Corrosion Weight 125 lb., # 304 Stainless Steel, 4" Pipe Size, Schedule 5.	2	each	\$ 60.00	\$ 120.00
2.	Welding Neck Flange, Part No. 111, Ideal IPS Corrosion Weight 125 lb., 4" Pipe Size, Schedule 5.	2	each	23.00	46.00

Total: \$ 166.00

Ceramaseal, a division of Ceramx
P.O. Box 260
New Lebanon, NY 12125
Tel. (518) 794-7800
FAX. (518) 794-8080

<u>Item</u>	<u>Description</u>	<u>Qty</u>	<u>Unit</u>	<u>Price (ea)</u>	<u>Total</u>
1.	Ceramaseal 802 Series Fluted High Voltage Ceramic Insulator, 43.8 kV RMS average flashover, # 802A0690-2.	6	each	\$ 14.60	\$ 87.60

Total: \$ 87.60

EDAL Industries, Inc.
Attn: Dino Vagnini
4 Short Beach Road
East Haven, CT 06512
Tel. (203) 467-2591
FAX. (203) 469-5928

<u>Item</u>	<u>Description</u>	<u>Qty</u>	<u>Unit</u>	<u>Price (ea)</u>	<u>Total</u>
1.	EDAL Silicon High Voltage Board-Type Rectifier, DWG No. B902, 30 kV Operating Voltage, 3 A Output.	4	each	\$ 62.80	\$ 251.20

Total: \$ 251.20

Folsom Sheet Metal Works
718 Madison Street
Tallahassee, FL 32304
Tel. (904) 222-5141

<u>Item</u>	<u>Description</u>	<u>Qty</u>	<u>Unit</u>	<u>Price (ea)</u>	<u>Total</u>
1.	Copper Flashing, Cut into 6 inch wide Strips 12 ft long, for a total linear length of 100 ft.	1	each	\$ 176.25	\$ 176.25
2.	Copper Flashing, Cut into 3 inch wide strips 12 ft long, for a total linear length of 100 ft.	1	each	91.25	91.25

Total: \$ 267.50

Jax Valve & Fitting Co.
Attn: "Mike"
3633 Southside Blvd.
P.O. Box 16097
Jacksonville, FL 32245
Tel. (904) 642-2093
FAX. (904) 642-2096

<u>Line</u>	<u>Description</u>	<u>Qty</u>	<u>Unit</u>	<u>Price (ea)</u>	<u>Total</u>
1.	Swagelok Male Connector, #NY-200-1-2.	2	each	\$ 2.60	\$ 5.20
2.	Swagelok Male Connector, #NY-400-1-4.	2	each	1.90	3.80
3.	Swagelok Male Connector, #NY-600-1-6	2	each	2.90	5.80
4.	Swagelok Male Elbow, #NY-600-2-6.	2	each	7.00	14.00
5.	Swagelok Union Elbow, #NY-600-9.	2	each	5.40	10.80
6.	Swagelok Union Tee, #NY-600-3.	2	each	8.10	16.20
7.	Swagelok Union Tee, #NY-400-3.	2	each	6.30	12.60
8.	Cajon Pipe Plug, #NY-2-P.	2	each	7.80	15.60
9.	Cajon Pipe Plug, #NY-4-P.	2	each	8.30	16.60
10.	Swagelok Female Elbow, #NY-400-8-4.	2	each	4.90	9.80
11.	Swagelok Union, #NY-600-6.	2	each	4.20	8.40

12.	Swagelok Union, #NY-400-6.	2	each	\$ 2.70	\$ 5.40
13.	Swagelok Female Elbow, NY-400-8-6.	1	each	22.60	22.60
14.	Swagelok Reducer, #NY-600-R-4.	1	each	5.60	5.60
15.	Swagelok Ferrule Sets, #NY-200-Set.	10	each	.61	6.10
16.	Swagelok Ferrule Sets, #NY-400-Set.	20	each	.53	10.60
17.	Swagelok Ferrule Sets, #NY-600-Set.	20	each	.66	13.20
18.	Whitey 3-way Ball Valve, with 3/8" Swagelok Conn., #SS-44XS6.	1	each	129.40	129.40
19.	Swagelok Male Connector, #SS-400-1-4.	8	each	5.10	40.80
20.	Swagelok Male Connector, #SS-600-1-6.	4	each	7.80	31.20
21.	Swagelok Male Connector, #SS-810-1-8.	4	each	11.60	46.40
22.	Swagelok Union, #SS-400-6.	2	each	7.80	15.60
23.	Swagelok Union, #SS-600-6.	2	each	11.20	22.40
24.	Swagelok Union, #SS-810-6.	2	each	16.80	33.60
25.	Swagelok Reducing Union, #SS-600-6-4.	1	each	11.20	11.20
26.	Swagelok Reducing Union, #SS-810-6-4.	1	each	17.40	17.40

27.	Swagelok Reducing Union, #SS-810-6-6.	1	each	\$ 17.40	\$ 17.40
28.	Swagelok Union Cross, #SS-400-4.	1	each	29.30	29.30
29.	Swagelok Union Cross, #SS-600-4.	1	each	36.40	36.40
30.	Swagelok Union Cross, #SS-810-4.	1	each	41.00	41.00
31.	Swagelok Ferrule Sets, #SS-400-Set.	10	each	1.38	13.80
32.	Swagelok Ferrule Sets, #SS-600-Set.	10	each	1.71	17.10
33.	Swagelok Ferrule Sets, #SS-810-Set.	10	each	2.43	24.30
34.	Swagelok Plug, #SS-400-P.	2	each	3.90	7.80
35.	Swagelok Plug, #SS-600-P.	4	each	4.40	17.60
36.	Swagelok Plug, #SS-810-P.	2	each	6.60	13.20

Total: \$ 748.20

W. W. Grainger, Inc.
3924 W. Pensacola St.
Tallahassee, FL 32304-2838
Tel. (904) 575-4137
FAX. (904) 575-1764

<u>Item</u>	<u>Description</u>	<u>Qty</u>	<u>Unit</u>	<u>Price (ea)</u>	<u>Total</u>
1.	Teel Stainless Steel Ball Valve, 316 SS, 1/2" NPT Inlet and Outlet, Stock # 2P282.	2	each	29.90	59.80
2.	Teel Stainless Steel Ball Valve, 316 SS, 1/4" NPT Inlet and Outlet, Stock # 2P281.	2	each	28.80	57.60

Total: \$ 117.40

APPENDIX II - Power Supply Operating Manual

HIGH VOLTAGE POWER SUPPLY

INSTRUCTION MANUAL

MODEL NUMBER **BAL-130-28-T**

SERIAL NUMBER **94-9-6011**



Universal Voltronics
Power Supplies that never quit.

Universal Voltronics • 27 Radio Circle Drive • Mt. Kisco NY 10549 • 914-241-1300 • FAX 914-241-3129

OPERATING INSTRUCTIONS FOR LABTROL POWER SUPPLY

BA I-130-28-T

TABLE OF CONTENTS:

- I. WARRANTY**
- II. UNPACKING INSTRUCTIONS**
- III. MECHANICAL SETUP**
- IV. ELECTRICAL SETUP**
- V. OPERATING INSTRUCTIONS**
- VI. THEORY OF OPERATION: CONTROL ASSEMBLY**
- VII. COMPONENT FUNCTIONS: HV ASSEMBLY**
- VII. DRAWINGS
SPECIFICATIONS
REPLACEMENT BILL OF MATERIAL**



**UNIVERSAL
VOLTRONICS CORPORATION**
27 Radio Circle Drive, Mt. Kisco, N.Y. 10549

1WX # 710-571-2142

WARRANTY AND SERVICE POLICY

1.0 Introduction:

Universal Voltronics Corp. has developed and installed a considerable number of high voltage power supplies and control equipments. In order to achieve optimum performance and maintain good customer relationships, UVC maintains a full-time field service organization giving both national and international coverage to take care of cases of pre-turn-on meetings, initial turn-on, as well as repair problems.

All UVC power supplies are completely factory-tested and warranted per the attached document. It is to be recognized that unusual operating conditions arise in the field which are of such a nature as to make it impossible for a manufacturer of electrical equipment to simulate in factory tests. The final test is operation with the customer load and ambient conditions.

With this as background, UVC reviewed the various problems and offers the following program to assist its customers in getting prompt turn-on, reliable operation and rapid field service.

2.0 Initial Turn-On:

UVC makes available qualified engineering personnel to be present at the site to assist the customer before and during the initial turn-on to verify proper electrical performance. This includes wiring checkout between input mains and the high voltage output terminal. A complete electrical check is made to verify that the equipment has been installed and set up properly. (See cost schedule below, #5.0.)

3.0 Field Repair and Service Responsibility:

(Repair, Application Analysis, Circuit Improvement, etc.)

Based on our experience, we find that there are three main areas of definition as regards field service problems, as follows:

3.1 Full UVC Responsibility:

This covers the case (within the warranty period) where the equipment furnished by Universal Voltronics Corp. does not operate properly due to manufacturing or design defects. This would include such things as voltage control not functioning properly, transformer-rectifier failure, metering errors, etc. These are clearly UVC's responsibility, would be considered in-warranty repairs, and all repair costs would be absorbed by UVC.

3.2 Customer Full Responsibility:

This covers the case (whether it be in or out of warranty) in which the customer has mis-applied or misused the equipment. Examples of this would be undersized or oversized equipment. This could happen when the customer has not had the opportunity to fully test his system and hence finds that the device furnished by UVC does not match the characteristics of his load. Another example is equipment damage resulting from electrical mis-wiring in the field, causing damage to the electrical parts. These are cases where all costs are paid by the UVC customer.

3.3 Joint Responsibility:

This covers the case where UVC and the customer have worked jointly on a project where all the parameters were not fully established during the design and conception stages. In this particular case, UVC will make available competent personnel to assist in the engineering to adapt to the particular site requirements. In the case of joint responsibility, the rates are to be negotiated between UVC Service Department and the customer. The final costs depend on the specific situation and should be agreed upon during the pre-contract period.

4.0 Shipping Damage:

We have found that on occasion, equipment arrives at the site damaged due to rough handling in shipment and installation at site. The difficulty is that the processing of a claim for shipping damage is generally beyond the control of UVC.

We assume that once the equipment arrives at the site, it is inspected by the customer's personnel and a claim processed in the event of shipping damage. We would, of course, repair and rework the equipment, either at the site or at the factory, depending on the extent of the damage. It is to be recognized that these repair costs will not be absorbed by UVC.

NOTE

**GOOD ENGINEERING PRACTICE
HAS BEEN INCORPORATED TO ENSURE
SAFE SHIPMENT. THIS DOES NOT
PRECLUDE DAMAGE DUE TO SEVERE
SHOCK AND EXTREME VIBRATION SOMETIMES
ENCOUNTERED IN LONG-DISTANCE SHIPMENT.**

4. Set the reversing plate to the desired polarity. The jumpers and banana plugs on the square lucite plate have been designed to mate with the four banana jacks on the lucite shelf. The jumpers and plugs can connect the system for either positive output, negative ground, or negative output, positive ground. The silk-screened code shows how to connect the jumpers to obtain the desired output polarity.
5. Remove the plastic plug from the output cable well. Insert the output cable plug in the well and tighten the retaining nut.

NOTE

**STEPS 4 AND 5 MAY BE
COMPLETED AFTER THE HIGH
VOLTAGE ASSEMBLY HAS BEEN
SET UP AND FILLED WITH OIL.
HOWEVER, IT IS SIMPLIER TO
COMPLETE THESE STEPS AT THIS POINT.**

6. Cut the cord holding the high voltage safety switch solenoid.
7. Return the high voltage assembly to the tank and replace the lid-to-tank sealing bolts.

C. CONTROL ASSEMBLY CARTON

Open the control assembly carton, using conventional receiving department techniques. The carton has been packed with sufficient shock-absorbing material to protect the control assembly during transcontinental shipment.

D. INSPECTION: CONTROL ASSEMBLY

1. Open the rear access door and top cover by means of the handle and/or screws.
2. Carefully inspect all components, structures, and wiring for damage.
3. The cabinet may be left open until the electrical setup (covered in Section III, below) is completed. This will facilitate required interconnections.

III. MECHANICAL SETUP

A. LOCATION: HIGH VOLTAGE TANK AND CONTROLS

The control assembly may be mounted in any convenient location. The controls may be rack-mounted by removing the control assembly from its cabinet and remounting it in the customer's rack.

The high voltage tank must be located so that the interconnecting cable to the control assembly mates.

B. OIL FILL AND TYPE

Fill the tank with a high-quality mineral base transformer oil through the access hole on the top of the tank. Feed the oil-fill pipe far enough into the access hole to avoid splashing. Fill the tank with oil to a level approximately one inch beneath the lid when the high voltage assembly is immersed and the oil temperature is approximately 25°C. An exhaust pipe fitting has been provided on the tank wall. This pipe will assist the user if it is necessary to purify or cool the oil by circulating it. Fitting the exhaust pipe with a valve will facilitate oil sampling, changing, and purification.

C. RECOMMENDED OILS

Shell Diala - AX; Exxon Univolt 33, Gulf 33

CAUTION

**USE MINERAL BASE TRANSFORMER
OILS ONLY. CHLORINATED OILS
SUCH AS PYRANOL, DYKANOL, INERTEEN,
ETC., ARE HIGHLY DESTRUCTIVE TO
THE INTERNAL MATERIALS USED.**

IV. ELECTRICAL SETUP

A. GROUND

Connect a heavy ground wire (minimum #10) to the ground studs. A pin and wire in the interconnecting AN connector are provided to ensure all grounds of being connected.

B. EXTERNAL INTERLOCK

Connect two wires (minimum #20) to the two-position "External Interlock" terminal board behind the control panel. Connect the other ends of these two wires to a normally open (NO) switch (or other interlock device) that must be closed to achieve HIGH VOLTAGE ON operation. If no switch or interlock device is used, place a jumper wire across the two terminals (#1 and #2).

C. CONTROL TRANSFORMER

an auxiliary
stepdown control transformer (T-5) provides isolated 120V for the control circuits.

D. INTERCONNECTION: HIGH VOLTAGE ASSEMBLY TO CONTROL

The multiconductor interconnecting cable allows ready hookup between the control circuit and high voltage assembly. The mating plugs and jacks are coded male/female to eliminate the possibility of a wrong connection. The receptacles for the cable plugs are located on the roof of each cabinet.

E. HIGH-VOLTAGE CABLE

The high-voltage cable has been stripped at the factory to operate at rated voltage. Connect the load end of the cable to the load.

It is good high-voltage practice to keep terminations as corona-free as possible. We recommend the use of High Voltage Terminations as shown on UVC Bulletin C70-7, "HIGH VOLTAGE TERMINATIONS," included with this manual.

F. INPUT

Wire the Terminal Board provided for input on the rear of the chassis. The proper voltage and frequency of the power source are as follows:

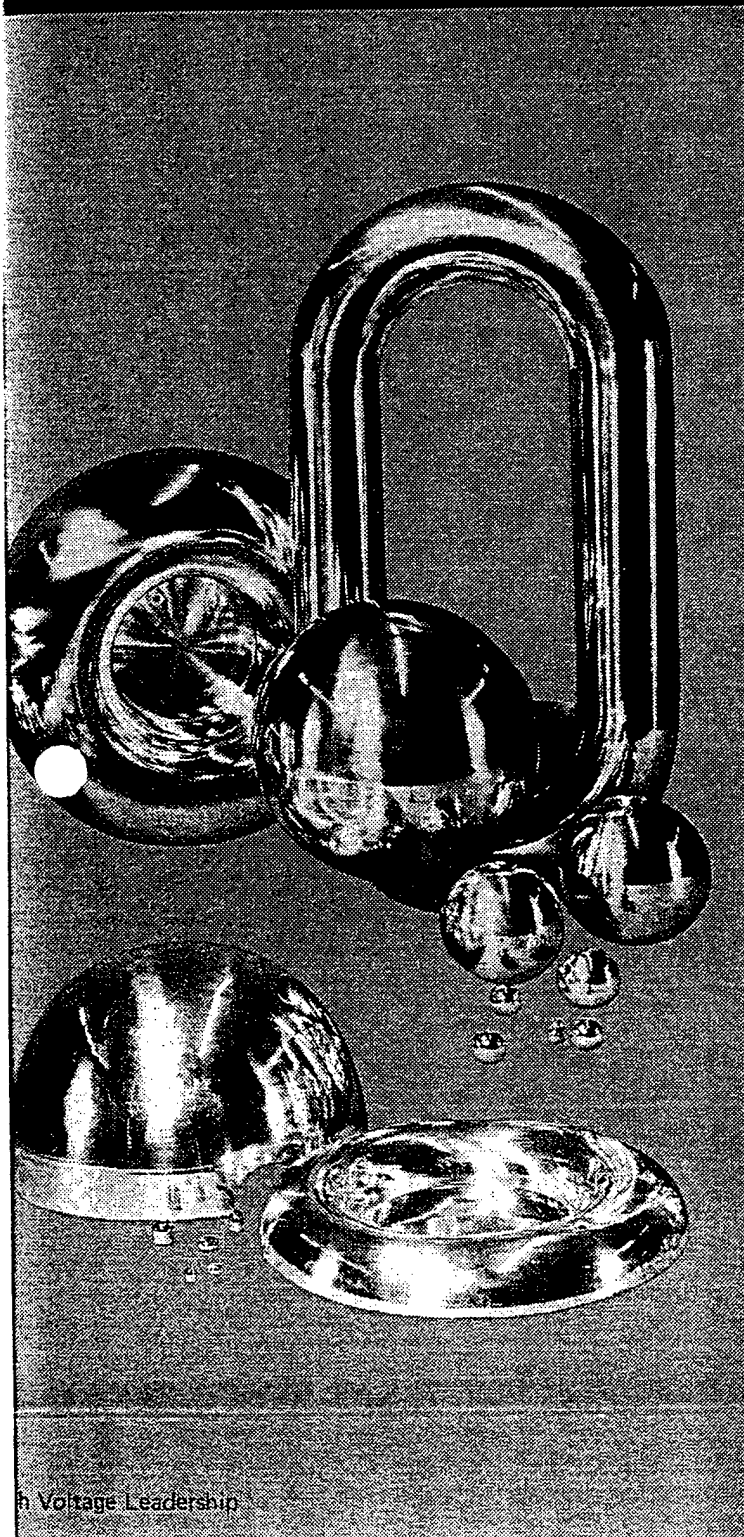
Input: 208, 230V 1PHASE. 60Hz. 7KVA, approx.

WYE INPUT REQUIRED

Input details are given by model number on the enclosed UVC bulletin, BA70-10, "Adjustable High Voltage DC Power Supplies."

HIGH VOLTAGE TERMINATIONS

C70-7



- MINIMIZE LEAKAGE AND CORONA LOSSES
- PROVIDE PREDICTABLE PERFORMANCE
- PERMIT CLOSER SPACING OF HIGH VOLTAGE COMPONENTS
- INCREASE RELIABILITY
- SIMPLIFY WIRING AND TERMINATION PROBLEMS

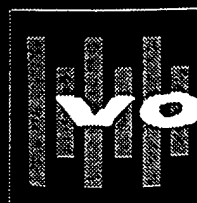
UVC high voltage terminations and connection links have been designed and fabricated specifically for use in high voltage applications requiring careful attention to terminal and connection problems. The standard terminations have been manufactured in a variety of geometrical configurations which have been chosen for their well-defined corona and leakage onset characteristics. Accurate machining and polishing, along with adequate theoretical and field experience on these terminals have given UVC the ability to advise on a particular size, shape or spacing for a particular application or site condition.

Corona-free terminations are vital in high voltage work, as corona stress reduction eliminates generated radio interference and the deterioration of insulation. Carefully designed high voltage terminations represent the most fundamental and successful method of eliminating insulation break down and corona discharge problems. This is especially true with organic insulating materials such as varnishes, bonds, cellulose, natural rubber, neoprene, etc.

The predictable performance obtained with these terminations, along with their low cost and ease of installation, can add greatly to your systems' or products' reliability.

Basic electrostatic theory shows that sharp points, edges, corners, etc. represent discontinuities in the mapping of equipotential surfaces. It is precisely these discontinuities that create unpredictable high voltage performance. Capping these points with a simple conducting termination eliminates the high stress points (discontinuities) in favor of a more linear distribution of voltage gradients.

High Voltage Leadership



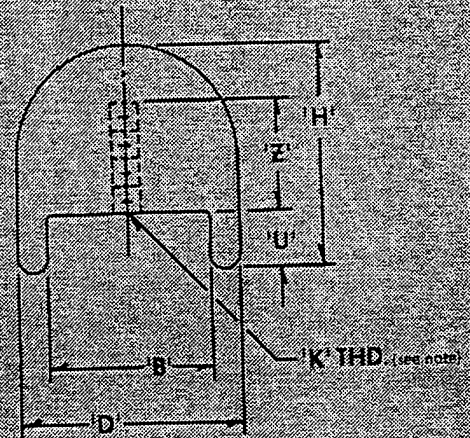
**UNIVERSAL
VOLTRONICS
CORPORATION**

27 Radio Circle Drive, Mount Kisco, N.Y., 10549
(914) 241-1300

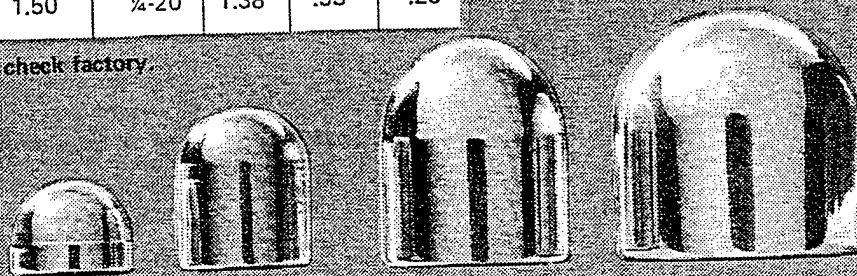
CAP NUTS-SERIES TC

This terminal family is essentially a modification of a sphere and finds wide use in lower voltage applications. An undercut permits ease of lug connection without sacrificing proper corona-free characteristics. The cap nuts are machined from brass and have a chrome polish with a high finish. They are available in other materials to special order.

Recommended Voltage	Part No.	"D" Dia.	"H" Dim.	"K" * THD	"B" Dia.	"Z" Dim.	"U" Dim.
15 KV	TC-15	.50	.63	4-40	.38	.34	.22
15 KV	TC-15-1	.50	.38	4-40	.38	.19	.16
25 KV	TC-25	.75	.88	10-32	.63	.94	.28
35 KV	TC-35	1.0	1.0	1/4-20	.88	.53	.34
50 KV	TC-50	1.50	1.50	1/4-20	1.38	.53	.25

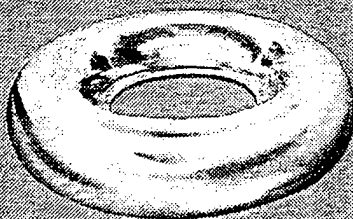
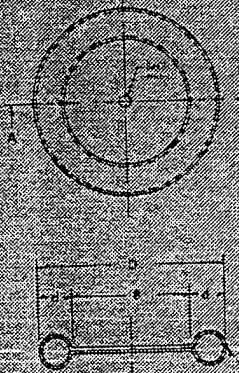


*Note: Other THD's available — check factory.



TOROID-SERIES TTW

The operating characteristics of the toroid are quite well known in the high voltage industry. Because of the clean and polished seam, the voltage characteristics are accurately predictable and are used where critical voltage characteristics are required.

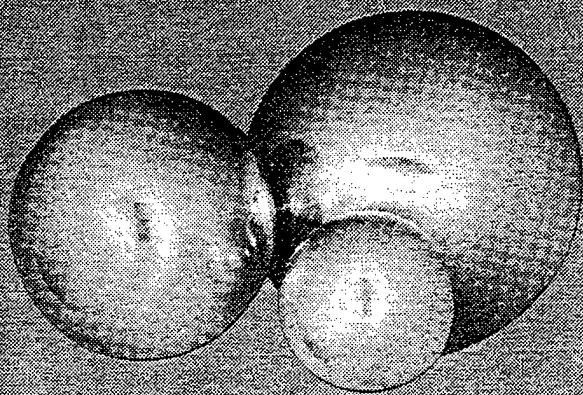


Recommended Voltage	Part No.	"d" Dia. (inches)	"D" Dia. (inches)	"B" Dia. (inches)
30-KV	TTW- 30	.50	4.0	3.0
50-KV	TTW- 50	1.0	4.0	2.0
80-KV	TTW- 80	1.0	14.0	12.0
90-KV	TTW- 90	1.75	7.0	3.50
100-KV	TTW-100	1.50	15.75	12.75
125-KV	TTW-125	2.50	10.0	5.0
175-KV	TTW-175	2.50	24.0	19.0
175-KV	TTW-175-1	3.50	14.0	7.0
220-KV	TTW-220	3.0	30.50	24.50
240-KV	TTW-240	4.50	18.0	9.0
300-KV	TTW-300	6.0	24.0	12.0
300-KV	TTW-300-1	7.0	20.0	6.0
375-KV	TTW-375	6.0	40.0	28.0
375-KV	TTW-375-1	7.0	28.0	14.0
400-KV	TTW-400	8.50	34.0	17.0
450-KV	TTW-450-1	9.0	30.0	12.0
500-KV	TTW-500	10.0	40.0	20.0
800-KV	TTW-800	14.0	68.0	40.0

Note: Hole Diameter to be specified when ordering.

SPHERES-SERIES TS

Spheres represent one of the most common techniques for capping stress points and find wide usage in virtually all applications. They also find wide use in sphere gap measurements. (See technical discussion.) Diameters of up to 4 ft. have been used in some installations and are available on special order. The standard material is aluminum (above 1" dia.) or brass. Copper has been used for special applications, especially for sphere gap work.



Recommended Voltage	Part No.	Fig.	"D" (inches)	"T" (T.H.D.)	"T.D." (inches)
10-KV	TS- 10	1	.38	6-32	.25
20-KV	TS- 20	1	.50	6-32	.25
35-KV	TS- 35	1	1.00	8-32	.50
70-KV	TS- 70	2	2.00	1/4-20	.50
100-KV	TS-100	2	3.00	1/4-20	.50
130-KV	TS-130	2	4.00	1/4-20	.50
165-KV	TS-165	2	5.00	1/4-20	.50
200-KV	TS-200	2	6.00	1/4-20	.50
250-KV	TS-250	2	7.00	1/4-20	.50
300-KV	TS-300	2	8.00	1/4-20	.50
350-KV	TS-350	2	10.00	1/4-20	.50

Note: For Diameters above 10" consult factory.
Availability to 24".

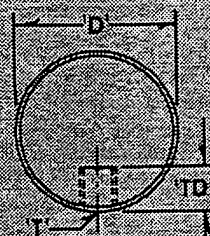


FIG. 2

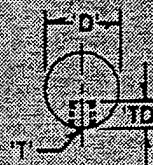
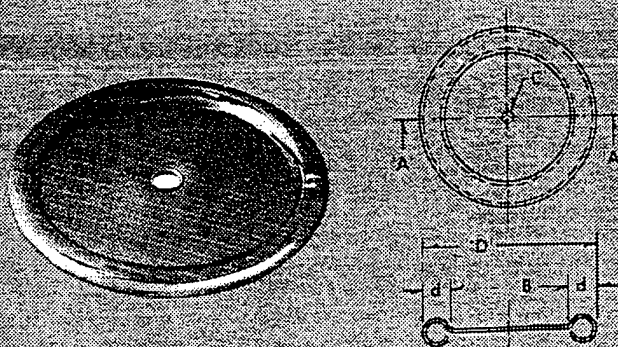


FIG. 1

TOROID, DISH-SERIES TD

This particular family of terminal has been developed to fill a need where multiple high voltage components are stacked up and the interfaces require a grading ring. The minor diameter allows for comparatively close spacing between the modules being stacked, while the major diameter allows for an overall high voltage with respect to ground. These have found wide application for series connections of resistors, rectifiers, capacitors, etc., where the terminal junctions require stress reduction.

Recommended Voltage	Part No.	"d" Dim. (inches)	"D" Dim. (inches)	"B" Dim. (inches)	"C" Dia. (inches)
15 KV	TD-15	.25	3.06	2.63	.25
30 KV	TD-30	.50	6.0	5.0	.25
30 KV	TD-30-1	.50	7.38	6.38	.25
40 KV	TD-40	.63	7.38	6.12	.25
45 KV	TD-45	.75	10.0	8.50	.25

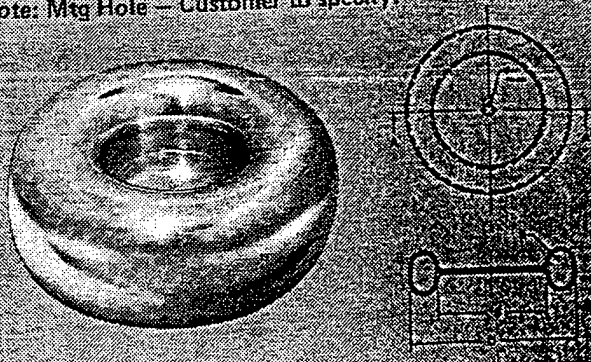


CLOSED TOROID, FLAT SIDES SERIES TTF

This particular type terminal has been developed for use where the conventional toroid (series TT, TTW) is somewhat limited. The elongated side of the terminal enhances its corona onset characteristic and hence higher voltage stresses may be utilized than on conventional toroids with comparatively little sacrifice in size.

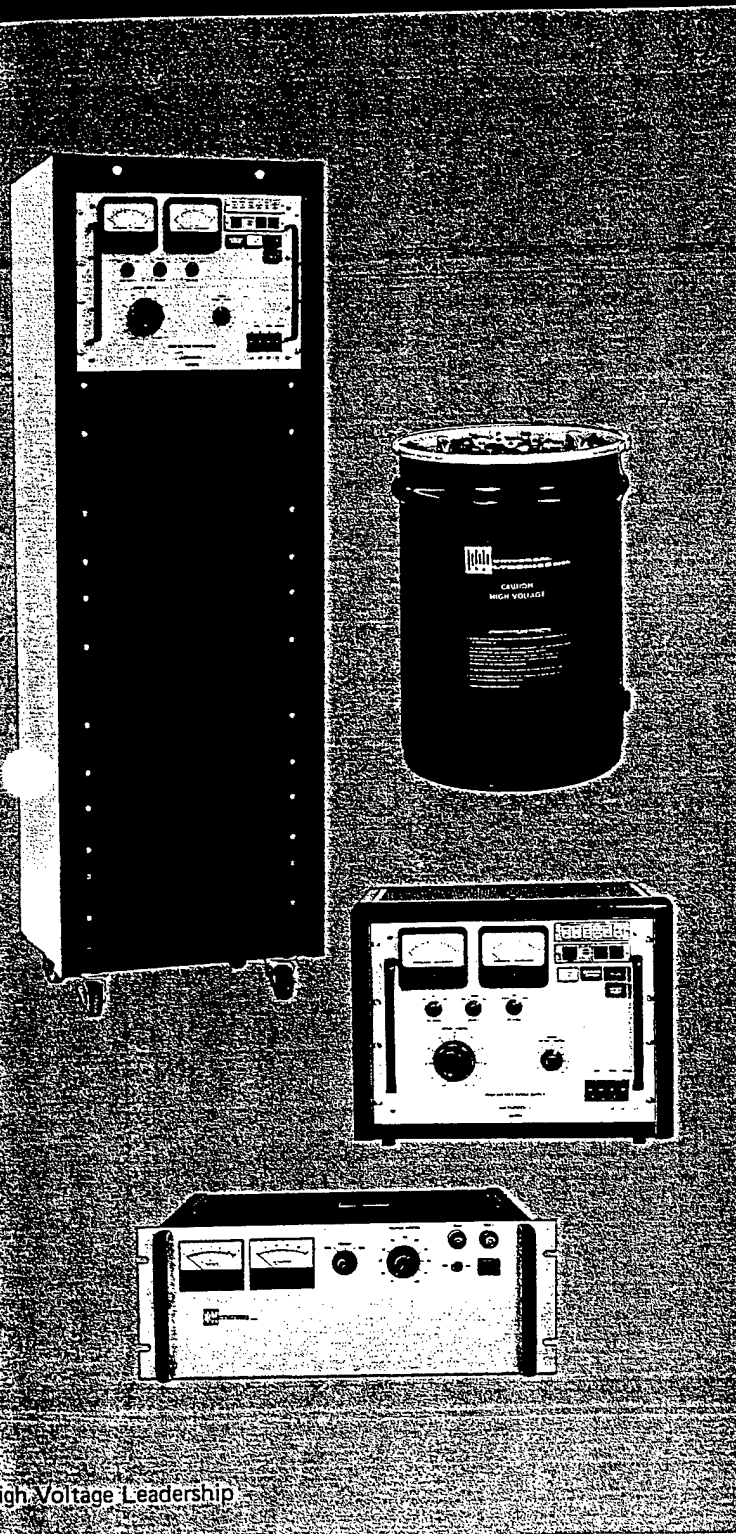
Recommended Voltage	Part No.	"d" Dia. (inches)	"D" Dia. (inches)	"R" Rad. (inches)	"B" Dia. (inches)
90-KV	TTF- 90	1.75	8.0	.50	6.0
220-KV	TTF-220	4.12	25.0	1.12	20.0
250-KV	TTF-250	7.0	16.0	2.50	6.0
275-KV	TTF-275	7.0	20.0	2.50	10.0
350-KV	TTF-350	9.0	21.0	3.50	7.0

Note: Mtg Hole — Customer to specify



ADJUSTABLE HIGH VOLTAGE DC POWER SUPPLIES

BA 70-10



High Voltage Leadership

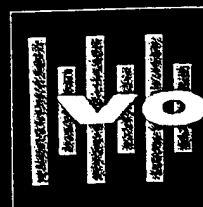
- VOLTAGE RANGES TO 300,000 VOLTS DC
- CONSERVATIVELY RATED – HIGH RELIABILITY
- REVERSIBLE POLARITY
- FULLY SELF PROTECTING
- OPTIONAL "APPLICATION ORIENTED" CONTROLS

Unmatched at present in the high voltage field, this most extensive line of rugged UVC High Voltage DC Power Supplies provides a wide variety of standard voltage and power ratings to answer the needs created by rapidly expanding applications for high voltage equipment. Over 100 basic models cover output voltage ranges up to 300 KV, with power capabilities up to 250 KW.

Virtually all UVC Power Supplies can be used with any of the three "application oriented" controls. These optional controls provide features specifically oriented toward research, general purpose, or industrial applications. This versatility provides an important advantage in economy, since there is no necessity to pay for features which may not be used in certain installations.

Electrical design is conservative, with transformers, rectifiers, capacitors, and other components used well below advertised full load ratings. Semi-conductor rectifiers are used in the majority of these supplies, for their rugged long life characteristics and overload capabilities. Specific and detailed attention has been given to both equipment and personnel protection and safety.

Versatile, rugged and totally dependable, UVC High Voltage Power Supplies provide new standards for exacting performance.



**UNIVERSAL
VOLTAGE
CORPORATION**

27 Radio Circle Drive, Mount Kisco, N.Y., 10549
(914) 241-1300

TABLE OF RATINGS AND SPECIFICATIONS

ADJUSTABLE
HIGH VOLTAGE
DC POWER SUPPLIES

Rated DC Voltage (Full Load)	Rated DC Current (MA)	Model Designation	Availability *	Ripple (% RMS) **	No Load Voltage (Approx.) (KV)	Input (60 CPS)		MECHANICAL				Insul. Med.	Output Cable Length (ft.)
								CONTROLS		HIGH VOLT. ASSEMBLY			
										Size (Inches) WxHxD	Weight (lbs.)		
0-2KV	40	BAM-2-40	M	2	2.4	115	1	19x7x15 1/2	22	†	—	Air	10
	100	BA *-2-100	L-C-M	2	2.4	115	1	19x10 1/2 x 14	35	†	—		10
	200	BA *-2-200	L-C-M	2	2.4	115	1	19x10 1/2 x 14	70	†	—		10
	400	BA *-2-400	L-C-M	2	2.4	115	1	19x14x17	145	†	—		10
	900	BA *-2-900	L-C-M	2	2.4	115	1	22x33 1/2 x 18	350	†	—		10
	1,800	BA *-2-1,800	L-C-M	2	2.4	208/230	1	22x72 1/2 x 18	500	†	—		15
	4,000	BA *-2-4,000	L-C-M	5	2.3	208/230	3	22x72 1/2 x 24	1,100	†	—		20
	8,000	BA *-2-8,000	L-C-M	5	2.3	208/230	3	22x42x18	500	22x52x18	1,000		20
	16,000	BA *-2-16,000	L-C-M	5	2.3	208/230	3	22x72 1/2 x 24	800	22x72 1/2 x 24	1,600		20
	24,000	BA *-2-24,000	L-C-M	5	2.3	208/230	3	33x72 1/2 x 24	1,000	33x72 1/2 x 24	2,000		20
	32,000	BA *-2-32,000	L-C-M	5	2.3	208/230	3	33x72 1/2 x 24	1,300	33x72 1/2 x 24	2,300		20
	50,000	BA *-2-50,000	L-C-M	5	2.3	440/480	3	33x72 1/2 x 24	1,800	34x72 1/2 x 34	2,500		20
	75,000	BA *-2-75,000	L-C-M	5	2.3	440/480	3	34x72 1/2 x 34	1,800				20
	100,000	BA *-2-100,000	L-C-M	5	2.3	440/480	3						20
	125,000	BA *-2-125,000	L-C-M	5	2.3	440/480	3						20
0-4KV	20	BAM-4-20	M	2	4.8	115	1	19x7x15 1/2	22	†	—		10
	50	BA *-4-50	L-C-M	2	4.8	115	1	19x10 1/2 x 14	35	†	—		10
	120	BA *-4-120	L-C-M	2	4.8	115	1	19x10 1/2 x 14	90	†	—		10
	200	BA *-4-200	L-C-M	2	4.8	115	1	19x14x17	145	†	—		10
	450	BA *-4-450	L-C-M	2	4.8	115	1	22x33 1/2 x 18	350	†	—		15
	900	BA *-4-900	L-C-M	2	4.8	208/230	1	22x72 1/2 x 18	500	†	—		20
	2,000	BA *-4-2,000	L-C-M	5	4.7	208/230	3	22x72 1/2 x 24	1,100	†	—		20
	4,000	BA *-4-4,000	L-C-M	5	4.7	208/230	3	22x42x18	500	22x52x18	1,000		20
	8,000	BA *-4-8,000	L-C-M	5	4.7	208/230	3	22x72 1/2 x 24	800	22x72 1/2 x 24	1,600		20
	12,000	BA *-4-12,000	L-C-M	5	4.7	208/230	3	33x72 1/2 x 24	1,000	33x72 1/2 x 24	2,000		20
	16,000	BA *-4-16,000	L-C-M	5	4.7	208/230	3	33x72 1/2 x 24	1,300	33x72 1/2 x 24	2,300		20
	25,000	BA *-4-25,000	L-C-M	5	4.7	440/480	3	34x72 1/2 x 34	1,800	34x72 1/2 x 34	2,500		20
	37,500	BA *-4-37,500	L-C-M	5	4.7	440/480	3						20
	50,000	BA *-4-50,000	L-C-M	5	4.7	440/480	3						20
	62,500	BA *-4-62,500	L-C-M	5	4.7	440/480	3						20
0-6KV	5.5	BAM-6-5.5	M	1.5	7.3	115	1	19x5 1/2 x 15 1/2	20	†	—		10
	20	BA *-6-20	L-C-M	1.5	7.2	115	1	19x10 1/2 x 14	25	†	—		10
	50	BA *-6-50	L-C-M	2	7.2	115	1	19x10 1/2 x 14	30	†	—		10
	80	BA *-6-80	L-C-M	2	7.3	115	1	19x14x17	90	†	—		10
	125	BA *-6-125	L-C-M	2	7.3	115	1	19x14x17	140	†	—		10
	300	BA *-6-300	L-C-M	2	7.3	115	1	22x33 1/2 x 18	350	†	—		15
	600	BA *-6-600	L-C-M	2	7.3	208/230	1	22x72 1/2 x 18	500	†	—		20
	1,350	BA *-6-1,350	L-C-M	5	7.3	208/230	3	22x72 1/2 x 24	1,100	†	—		20
	2,750	BA *-6-2,750	L-C-M	5	7.3	208/230	3	22x42x18	500	22x52x18	1,000		20
	5,500	BA *-6-5,500	L-C-M	5	7.3	208/230	3	22x72 1/2 x 24	800	22x72 1/2 x 24	1,600		20
	8,000	BA *-6-8,000	L-C-M	5	7.3	208/230	3	33x72 1/2 x 24	1,000	33x72 1/2 x 24	2,000		20
	10,600	BA *-6-10,600	L-C-M	5	7.3	208/230	3	33x72 1/2 x 24	1,300	33x72 1/2 x 24	2,300		20
	16,700	BA *-6-16,700	L-C-M	5	7.3	440/480	3	34x72 1/2 x 34	1,800	37x72 1/2 x 34	2,500		20
	25,000	BA *-6-25,000	L-C-M	5	7.3	440/480	3						20
	33,400	BA *-6-33,400	L-C-M	5	7.3	440/480	3						20
41,800	BA *-6-41,800	L-C-M	5	7.3	440/480	3					20		
0-10KV	5.5	BAM-10-5.5	M	1.5	12.0	115	1	19x5 1/2 x 15 1/2	25	†	—		10
	20	BA *-10-20	L-C-M	2.5	12.0	115	1	19x10 1/2 x 14	30	†	—		10
	50	BA *-10-50	L-C-M	2	12.0	115	1	19x14x17	90	†	—		10
	80	BA *-10-80	L-C-M	2	12.0	115	1	19x14x17	160	†	—		10
	180	BA *-10-180	L-C-M	3	12.0	115	1	22x33 1/2 x 18	350	†	—		15
	360	BA *-10-360	L-C-M	4	12.0	208/230	1	22x72 1/2 x 18	500	†	—		20
	800	BA *-10-800	L-C-M	5	12.0	208/230	3	22x72 1/2 x 24	1,100	†	—		20
	1,600	BA *-10-1,600	L-C-M	5	12.0	208/230	3	22x42x18	500	22x52x18	1,000		20
	3,200	BA *-10-3,200	L-C-M	5	12.0	208/230	3	22x72 1/2 x 24	800	22x72 1/2 x 24	1,600		20
	4,800	BA *-10-4,800	L-C-M	5	12.0	208/230	3	33x72 1/2 x 24	1,000	33x72 1/2 x 24	2,000		20
	6,400	BA *-10-6,400	L-C-M	5	12.0	208/230	3	33x72 1/2 x 24	1,300	33x72 1/2 x 24	2,300		20
	10,000	BA *-10-10,000	L-C-M	5	12.0	440/480	3	34x72 1/2 x 34	1,800	34x72 1/2 x 34	2,500		20
	15,000	BA *-10-15,000	L-C-M	5	12.0	440/480	3						20
	20,000	BA *-10-20,000	L-C-M	5	12.0	440/480	3						20
	25,000	BA *-10-25,000	L-C-M	5	12.0	440/480	3						20
0-16KV	5.5	BAM-16-5.5	M	1.5	18.0	115	1	19x5 1/2 x 15 1/2	30	†	—		10
	20	BA *-16-20	L-C-M	2	19.0	115	1	19x10 1/2 x 14	45	†	—		10
	30	BA *-16-30	L-C-M	2	20.0	115	1	19x14x17	90	†	—		10
	50	BA *-16-50	L-C-M	2	20.0	115	1	19x14x17	160	†	—		10
	110	BA *-16-110	L-C-M	3	20.0	115	1	22x33 1/2 x 18	350	†	—		15
	225	BA *-16-225	L-C-M	4	20.0	208/230	1	22x72 1/2 x 18	500	†	—		20

The third letter in the model designation is either L, C, or M to denote the type of controls required. The optional controls available for any given model are indicated under "Availability" in table above.

Example: BA *-2-400
For Labtrol—Model Designation is BAL-2-400
For Control—Model Designation is BAC-2-400
For Mintrol—Model Designation is BAM-2-400

Rated DC Voltage (Full Load)	Rated DC Current (MA)	Model Designation	Avail-ability *	Ripple (% RMS) **	No Load Voltage (Approx.) (KV)	Input (60 CPS)		MECHANICAL				Insul. Med.	Output Cable Length (ft.)		
								CONTROLS		HIGH VOLT. ASSEMBLY					
						Volts	Ø	Size (Inches) WxHxD	Weight (lbs.)	Size (Inches) WxHxD	Weight (lbs.) ††				
0-16KV	500	BA *-16-500	L-C-M	5	18	208/230	3	22x72½x24	1,100	†	—	Air	20		
	1,000	BA *-16-1,000	L-C-M	5	18	208/230	3	22x42x18	500	22x72½x24	1,000		20		
	2,000	BA *-16-2,000	L-C-M	5	18	208/230	3	22x72½x24	800	27x72½x24	1,600		20		
	3,000	BA *-16-3,000	L-C-M	5	18	208/230	3	33x72½x24	1,000	33x72½x24	2,000		20		
	4,000	BA *-16-4,000	L-C-M	5	18	208/230	3	33x72½x24	1,300	33x72½x24	2,300		20		
	6,250	BA *-16-6,250	L-C-M	5	18	440/480	3	34x72½x34	1,800	34x72½x34	2,500		20		
	9,400	BA *-16-9,400	L-C-M	5	18	440/480	3	Check factory					20		
	12,500	BA *-16-12,500	L-C-M	5	18	440/480	3	Check factory					20		
	15,600	BA *-16-15,600	L-C-M	5	18	440/480	3	Check factory					20		
								Check factory					20		
0-22KV	5.5	BAM-22-5.5	M	1.5	26	115	1	19x5¼x15¼	35	†	—		10		
	10	BA *-22-10	L-C-M	1.5	26	115	1	19x10¼x13	38	†	—		10		
	20	BA *-22-20	L-C-M	2	27	115	1	19x17¼x17	90	†	—		10		
	35	BA *-22-35	L-C-M	3	27	115	1	19x17¼x17	160	†	—		10		
	80	BA *-22-80	L-C-M	3	27	115	1	22x33¼x18	350	†	—		10		
	160	BA *-22-160	L-C-M	4	27	208/230	1	22x72½x18	500	†	—		15		
	360	BA *-22-360	L-C-M	5	27	208/230	3	22x72½x24	1,100	†	—		20		
	750	BA *-22-750	L-C-M	5	27	208/230	3	22x42x18	500	22x72½x24	1,000		20		
	1,500	BA *-22-1,500	L-C-M	5	27	208/230	3	22x72½x24	800	26x40x50	2,500		20		
	2,100	BA *-22-2,100	L-C-M	5	27	208/230	3	33x72½x24	1,000	30x42x42	2,800		20		
	2,900	BA *-22-2,900	L-C-M	5	27	208/230	3	33x72½x24	1,300	30x42x42	3,000		20		
	4,550	BA *-22-4,550	L-C-M	5	27	440/480	3	34x72½x34	1,800	38x48x46	4,000		20		
	6,800	BA *-22-6,800	L-C-M	5	27	440/480	3	Check factory					20		
	9,100	BA *-22-9,100	L-C-M	5	27	440/480	3	Check factory					20		
	11,300	BA *-22-11,300	L-C-M	5	27	440/480	3	Check factory					20		
								Check factory					20		
								Check factory					20		
	0-32KV	1.5	BAM-32-1.5	M	.5	36	115	1	19x7x15¼	35	†		—	Oil	10
5.5		BA *-32-5.5	L-C-M	1.5	36	115	1	19x7x15¼	40	†	—	10			
10		BA *-32-10	L-C-M	2.5	36	115	1	19x17¼x17	60	†	—	10			
25		BA *-32-25	L-C-M	2	36	115	1	19x17¼x17	160	†	—	10			
55		BA *-32-55	L-C-M	3	36	115	1	22x33¼x18	350	†	—	10			
110		BA *-32-110	L-C-M	4	36	208/230	1	22x72½x18	500	†	—	15			
250		BA *-32-250	L-C-M	5	36	208/230	3	22x16¼x18	200	23¼ODx35¾H	650	20			
500		BA *-32-500	L-C-M	5	36	208/230	3	22x42x18	500	22x34x42	1,300	20			
1,000		BA *-32-1,000	L-C-M	5	36	208/230	3	22x72½x24	800	26x40x50	2,500	20			
1,500		BA *-32-1,500	L-C-M	5	36	208/230	3	33x72½x24	1,000	30x42x42	2,800	20			
2,000		BA *-32-2,000	L-C-M	5	36	208/230	3	33x72½x24	1,300	30x42x42	3,000	20			
3,120		BA *-32-3,120	L-C-M	5	36	440/480	3	34x72½x34	1,800	38x48x46	4,000	20			
4,700		BA *-32-4,700	L-C-M	5	36	440/480	3	Check factory					20		
6,250		BA *-32-6,250	L-C-M	5	36	440/480	3	Check factory					20		
7,820		BA *-32-7,820	L-C-M	5	36	440/480	3	Check factory					20		
								Check factory					20		
								Check factory					20		
0-50KV		1.5	BA *-50-1.5	L-C-M	1.5	60	115	1	22x19¼x18	100	†	—			10
	5.5	BA *-50-5.5	L-C-M	1.5	60	115	1	22x19¼x18	120	†	—	10			
	16	BA *-50-16	L-C-M	2	60	115	1	22x33¼x18	180	†	—	10			
	35	BA *-50-35	L-C-M	3	60	115	1	22x16¼x15	85	19¼ODx29¾H	320	10			
	70	BA *-50-70	L-C-M	4	60	208/230	1	22x16¼x18	135	23¼ODx35¾H	600	15			
	160	BA *-50-160	L-C-M	5	60	208/230	3	22x16¼x18	200	23¼ODx35¾H	700	20			
	325	BA *-50-325	L-C-M	5	60	208/230	3	22x42x18	500	26x40x50	1,800	20			
	650	BA *-50-650	L-C-M	5	60	208/230	3	22x72½x24	800	26x40x50	2,000	20			
	960	BA *-50-960	L-C-M	5	60	208/230	3	33x72½x24	1,000	30x42x42	2,500	20			
	1,280	BA *-50-1,280	L-C-M	5	60	208/230	3	33x72½x24	1,300	30x42x42	3,300	20			
	2,000	BA *-50-2,000	L-C-M	5	60	440/480	3	34x72½x34	1,800	38x48x46	4,300	20			
	3,000	BA *-50-3,000	L-C-M	5	60	440/480	3	Check factory						20	
	4,000	BA *-50-4,000	L-C-M	5	60	440/480	3	Check factory						20	
	5,000	BA *-50-5,000	L-C-M	5	60	440/480	3	Check factory						20	
								Check factory						20	
								Check factory						20	
	0-70KV	1.5	BA *-70-1.5	L-C-M	1.5	85	115	1	22x33¼x18	100	†	—			10
		5.5	BA *-70-5.5	L-C-M	1.5	85	115	1	22x33¼x18	120	†	—			10
12		BA *-70-12	L-C-M	2	85	115	1	22x33¼x18	180	†	—	10			
25		BA *-70-25	L-C-M	3	85	115	1	22x16¼x15	85	19¼ODx29¾H	320	10			
50		BA *-70-50	L-C-M	4	85	208/230	1	22x16¼x18	135	23¼ODx35¾H	600	15			
110		BA *-70-110	L-C-M	5	85	208/230	3	22x16¼x18	200	22x34x42	1,000	20			
225		BA *-70-225	L-C-M	5	85	208/230	3	22x42x18	500	26x40x50	1,800	20			
450		BA *-70-450	L-C-M	5	85	208/230	3	22x72½x24	800	26x40x50	2,000	20			
685		BA *-70-685	L-C-M	5	85	208/230	3	33x72½x24	1,000	26x40x50	3,000	20			
910		BA *-70-910	L-C-M	5	85	208/230	3	33x72½x24	1,300	30x42x42	4,500	20			
1,430		BA *-70-1,430	L-C-M	5	85	440/480	3	34x72½x34	1,800	54x44x74	6,000	20			
2,140		BA *-70-2,140	L-C-M	5	85	440/480	3	Check factory					20		
2,860		BA *-70-2,860	L-C-M	5	85	440/480	3	Check factory					20		
3,580		BA *-70-3,580	L-C-M	5	85	440/480	3	Check factory					20		
								Check factory					20		
								Check factory					20		

* Single package construction. The high voltage assembly is included with the controls.

** Ripple measured at rated voltage and current.

†† Weight includes insulating oil which is not shipped with unit.

ADJUSTABLE HIGH VOLTAGE DC POWER SUPPLIES

Rated DC Voltage (Full Load)	Rated DC Current (MA)	Model Designations	Availability *	Ripple (% RMS) **	No Load Voltage (Approx.) (KV)	Input (60 CPS)		MECHANICAL				Insul. Med.	Output Cable Length (ft.)
								CONTROLS		HIGH VOLT. ASSEMBLY			
						Volts	Ø	Size (Inches) WxHxD	Weight (lbs.)	Size (Inches) WxHxD	Weight (lbs.) ††		
0-100KV	1.5	BA *-100-1.5	L-C-M	1.5	110	115	1	22x33½x18	140	↑	—	Oil	15
	5.5	BA *-100-5.5	L-C-M	1.5	110	115	1	22x33½x18	180	↑	—		15
	18	BA *-100-18	L-C-M	3	120	115	1	22x16½x15	85	23%ODx35½H	550		15
	36	BA *-100-36	L-C-M	4	120	208/230	1	22x16½x18	135	23%ODx35½H	600		20
	80	BA *-100-80	L-C-M	5	120	208/230	3	22x16½x18	200	22x34x42	1,200		30
	160	BA *-100-160	L-C-M	5	120	208/230	3	22x42x18	500	26x40x50	1,800		30
	320	BA *-100-320	L-C-M	5	120	208/230	3	22x72½x24	800	26x40x50	2,200		30
	480	BA *-100-480	L-C-M	5	125	208/230	3	33x72½x24	1,000	26x40x50	3,000		30
	640	BA *-100-640	L-C-M	5	125	208/230	3	33x72½x24	1,300	30x42x42	4,500		30
	1,000	BA *-100-1,000	L-C-M	5	125	440/480	3	34x72½x34	1,800	54x44x74	6,000		20
	1,500	BA *-100-1,500	L-C-M	5	125	440/480	3	Check factory					20
	2,000	BA *-100-2,000	L-C-M	5	125	440/480	3	Check factory					20
	2,500	BA *-100-2,500	L-C-M	5	125	440/480	3	Check factory					20
0-130KV	1.5	BA *-130-1.5	L-C-M	1.5	155	115	1	22x16½x15	50	19%ODx29½H	300		15
	5.5	BA *-130-5.5	L-C-M	1.5	160	115	1	22x16½x15	50	19%ODx29½H	320		15
	14	BA *-130-14	L-C-M	3	160	115	1	22x16½x15	85	23%ODx35½H	600		15
	28	BA *-130-28	L-C-M	4	160	208/230	3	22x16½x18	135	22x34x28	1,200		20
	60	BA *-130-60	L-C-M	5	160	208/230	3	22x16½x18	200	26x40x50	2,400		30
	125	BA *-130-125	L-C-M	5	160	208/230	3	22x42x18	500	26x40x50	3,000		30
	250	BA *-130-250	L-C-M	5	160	208/230	3	22x72½x24	800	28x45x64	3,500		30
	370	BA *-130-370	L-C-M	5	160	208/230	3	33x72½x24	1,000	40x48x64	4,600		30
	500	BA *-130-500	L-C-M	5	160	208/230	3	33x72½x24	1,300	40x50x76	7,000		30
	770	BA *-130-770	L-C-M	5	160	440/480	3	34x72½x34	1,800	54x48x76	8,500		30
	1,150	BA *-130-1,150	L-C-M	5	160	440/480	3	Check factory				30	
	1,540	BA *-130-1,540	L-C-M	5	160	440/480	3	Check factory				30	
	1,920	BA *-130-1,920	L-C-M	5	160	440/480	3	Check factory				30	
0-160KV	1.5	BA *-160-1.5	L-C-M	1.5	185	115	1	22x16½x15	50	23%ODx35½H	600		15
	5.5	BA *-160-5.5	L-C-M	1.5	185	115	1	22x16½x15	60	23%ODx35½H	615		15
	11	BA *-160-11	L-C-M	2	185	115	1	22x16½x15	85	23%ODx35½H	635		15
	22	BA *-160-22	L-C-M	4	185	208/230	1	22x16½x18	135	22x34x28	1,200		20
	50	BA *-160-50	L-C-M	5	185	208/230	3	22x16½x18	200	26x40x50	2,500		30
	100	BA *-160-100	L-C-M	5	185	208/230	3	22x42x18	500	26x40x50	3,000		30
	200	BA *-160-200	L-C-M	5	185	208/230	3	22x72½x24	800	28x45x64	3,500		30
	300	BA *-160-300	L-C-M	5	185	208/230	3	33x72½x24	1,000	40x48x64	4,600		30
	400	BA *-160-400	L-C-M	5	185	208/230	3	33x72½x24	1,300	40x50x76	7,000		30
	625	BA *-160-625	L-C-M	5	185	440/480	3	34x72½x34	1,800	54x48x76	8,500		30
	935	BA *-160-935	L-C-M	5	185	440/480	3	Check factory				30	
	1,250	BA *-160-1,250	L-C-M	5	185	440/480	3	Check factory				30	
	1,560	BA *-160-1,560	L-C-M	5	185	440/480	3	Check factory				30	
0-200KV	1.5	BA *-200-1.5	L-C-M	2	240	115	1	22x16½x15	50	34x40x34	2,300		20
	5.5	BA *-200-5.5	L-C-M	2	240	115	1	22x16½x15	60	34x40x34	2,400		20
	9	BA *-200-9	L-C-M	2	240	115	1	22x16½x15	85	34x40x34	2,500		20
	18	BA *-200-18	L-C-M	4	240	208/230	1	22x16½x18	135	34x40x34	3,300		20
	40	BA *-200-40	L-C-M	5	240	208/230	3	22x16½x18	200	38x48x46	4,000		30
	80	BA *-200-80	L-C-M	5	240	208/230	3	22x42x18	500	40x48x64	5,000		30
	160	BA *-200-160	L-C-M	5	240	208/230	3	22x72½x24	800	40x48x64	5,500		30
	240	BA *-200-240	L-C-M	5	240	208/230	3	33x72½x24	1,000	40x48x64	6,000		30
	320	BA *-200-320	L-C-M	5	240	208/230	3	33x72½x24	1,300	40x50x76	7,000		30
	500	BA *-200-500	L-C-M	5	240	440/480	3	34x72½x34	1,800	54x48x76	8,500		30
	750	BA *-200-750	L-C-M	5	240	440/480	3	Check factory				30	
	1,000	BA *-200-1,000	L-C-M	5	240	440/480	3	Check factory				30	
	1,250	BA *-200-1,250	L-C-M	5	240	440/480	3	Check factory				30	
0-250KV	1.5	BA *-250-1.5	L-C-M	1	300	115	1	22x16½x15	60	42x55x50	4,500		20
	5.5	BA *-250-5.5	L-C-M	2	300	115	1	22x16½x15	85	42x55x50	4,700		20
	10	BA *-250-10	L-C-M	3	300	208/230	1	22x16½x18	130	42x55x50	5,000		20
	30	BA *-250-30	L-C-M	3	300	208/230	1	22x16½x18	200	40x50x76	8,000		20
	50	BA *-250-50	L-C-M	5	300	208/230	3	22x42x18	500	40x50x76	9,000		30
	100	BA *-250-100	L-C-M	5	300	208/230	3	22x72½x24	800	72x60x84	13,000		30
	150	BA *-250-150	L-C-M	5	300	208/230	3	33x72½x24	1,000	72x60x84	15,000		30
	250	BA *-250-250	L-C-M	5	300	208/230	3	33x72½x24	1,300	96x72x84	18,000		30
	500	BA *-250-500	L-C-M	5	300	440/480	3	Check factory				30	
0-300KV	1.5	BAL -300-1.5	L	1	360	115	1	22x16½x15	60	50x60x62	7,000		20
	5.5	BAL -300-5.5	L	2	360	115	1	22x16½x15	85	50x60x62	7,250		20
	10	BAL -300-10	L	3	360	208/230	1	22x16½x18	135	50x60x62	7,600		20
	25	BAL -300-25	L	3	360	208/230	1	22x16½x18	200	50x60x62	8,000		30
	50	BAL -300-50	L	5	360	208/230	3	22x42x18	500	72x60x84	15,000		30
	100	BAL -300-100	L	5	360	208/230	3	22x72½x24	800	72x60x84	16,000		30
	150	BAL -300-150	L	5	360	208/230	3	33x72½x24	1,000	72x60x84	17,000		30
	250	BAL -300-250	L	5	360	440/480	3	34x72½x34	1,800	96x72x84	20,000		30

GUIDE TO CONTROL FEATURES

ADJUSTABLE
HIGH VOLTAGE
DC POWER SUPPLIES

	Features	Labtrol	Control	Mintrol
Meters	Kilovoltmeter and Milliammeter	3 range 10%, 30%, 100% of Full Scale	2 range 50%, 100% of Full Scale	1 range
Controls	Overvoltage and Overcurrent Trip	Adjustable (0-120%)	Fixed (110%)	(* 1)
	Coarse High Voltage Control	•	•	•
	Vernier High Voltage Control	0.03% resolution on HV setting (*2)		
	"Overload By-Pass" Pushbutton	•	•	
	Zero Voltage Start and "Surge On" Pushbutton	•	•	
	"High Voltage On" Pushbutton (black)	•	•	•
	"High Voltage Off, Reset" Pushbutton (red)	•	•	•
	Main Circuit Breaker (*8)	•	•	•
	Control Circuit Breaker (*8)	•	•	•
	Primary Circuit Breaker (*8), (*3)	•	•	•
	Raise, Lower Pushbuttons (*4) Coarse Motorized Voltage Control	•	•	•
	Raise, Lower Pushbuttons (*5) Vernier Motorized Voltage Control	•		
Indicator Lights	Overvoltage (blue) and Overload (yellow)	•	•	(* 1)
	Set Controls to Zero (*6) (for Zero Voltage Start)	•	•	
	High Voltage Ready (green)	•	•	
	High Voltage On (red)	•	•	•
	Main Circuit Breaker Open	•	•	•
	Control Circuit Breaker Open	•	•	•
	Primary Circuit Breaker Open (*3)	•	•	•
	Interlock Open	•	•	•
	High Voltage Access Open	•	•	
	At Max. (*7)	•	•	•

- *1. Fixed (110%) overcurrent trip and indicator furnished on all Mintrols with ratings over 800 watts output.
- *2. Vernier not furnished on Labtrols above 64 KW. Available as option at additional cost.
- *3. Primary instantaneous trip relays are used rather than primary circuit breakers in units with output power ratings over 32 KW. Indicator light will read "AC Overload".
- *4. Motorized coarse voltage control applies to all units of 32 KW output and above.
- *5. Motorized vernier voltage control applies to 48 KW and 64 KW Labtrols only.
- *6. Units with motorized voltage controls read "Setting to Zero".
- *7. Applies to units with motorized voltage controls.
- *8. In supplies with out powers of 800 watts and below, it is in general more economical to use toggle switches and fuses in lieu of circuit breakers. In all cases, however, indicator lights are provided.

ADJUSTABLE OVERVOLTAGE AND OVERCURRENT TRIP CIRCUITS - Protect load circuits from excessive voltage or current by removing primary power when preset values are exceeded.

ZERO VOLTAGE START AND "SURGE ON" - To prevent accidental damage to loads, the output voltage adjustment controls must be at zero before high voltage can be applied. A "Surge On" pushbutton is provided for intentional surging on of high voltage. (Only provided on units 160 KV and below).

OVERLOAD BY-PASS - To capitalize on the generous short term overload capabilities of these supplies, a bypass button is provided to by-pass the overcurrent trip circuit and milliammeter for capacitor charging, etc. The overload light, however, will be illuminated to warn the operator that an overload exists. Circuit Breaker (or fuses) are the protective devices.

ALL UVC POWER SUPPLIES INCLUDE:

OUTPUT VOLTAGE ADJUSTMENT Output voltage is continuously variable over the entire range from 0 to rated voltage at full load. Due to the inherent regulation characteristic of these supplies, output voltage rises as load current is reduced. All UVC supplies are designed to operate intermittently at the no load voltages shown in the table.

HIGH VOLTAGE SAFETY GROUNDING SWITCH In the interest of personnel safety, the high voltage terminal is automatically short circuited to ground thru a current limiting resistor when the high voltage is turned off or if line power fails.

SERIES RESISTANCE IN OUTPUT CIRCUIT For both personnel and equipment protection, series resistance is

included in the output circuit to limit high peak short circuit currents.

REVERSIBLE POLARITY Either positive or negative outputs are available at the discretion of the user. Polarity is easily reversible by means of a plug and jack arrangement in the high voltage assembly.

PROTECTIVE DEVICES Meters, relays, and other control components are protected from accidental damage by shorts, overloads, and high voltage transients. Circuit breakers and/or fuses provide additional protection for high voltage and control circuitry.

UVC POWER SUPPLIES PROVIDE ADVANTAGES IN THESE IMPORTANT AREAS

OVERLOAD CAPABILITIES Conservative design and quality components provide UVC supplies with the ability to withstand current overloads for intermittent duty. This makes them ideally suited where current surges are encountered (pulse circuits, capacitor charging, etc.). An Overload By-pass is incorporated in Labtrol and Comtrol units to allow only the primary circuit breaker (or fuse) to act as the protective device. The circuit breaker (or fuse) Time vs Percent Overload characteristic has been selected to match the power supply.

OPTIONAL CONTROL PANELS Virtually all UVC power supplies can be used with any of three "application oriented" controls. This versatility provides an important advantage in economy, since there is no necessity to pay for features which may not be used in certain applications.

OPERATION ABOVE RATED VOLTAGE To obtain adequate safety factor for trouble-free and reliable operation, all UVC supplies use components designed to operate at the "no load" voltage shown in the table. Thus, at reduced load currents, UVC supplies may provide output voltages above rated full load voltage for short term tests. Approximate operating voltages for reduced load currents can be computed from the linear relationship of voltage and current, using the "no load" and "full load" values shown in the table. While all UVC supplies are checked at their "no load" voltage prior to shipment from our factory, it should be understood that operation above rated voltage is achieved at the sacrifice of safety factor, and that component life may be affected. Consult factory for more details.

GENERAL INFORMATION

INPUT CONNECTIONS—Depending upon input power, a line cord, receptacle, or terminal board is provided for input power.

OUTPUT CONNECTIONS—All units with output voltages up to and including 300 KV are provided with a high voltage output cable (see table).

REMOTE OPERATION—Almost all UVC supplies are suitable for remote operation, i.e., the controls may be operated remotely from the high voltage assembly. The only exceptions are in the lower voltage units (32 KV and below) with outputs of 800 watts or less. Interconnecting

cables normally supplied with each unit are approximately 10 feet in length. Longer cables are available on special order.

AMBIENT TEMPERATURE—0-40°C.

ALTITUDE—Oil insulated units (50 KV and above) are operable up to 10,000 feet. Check factory for higher altitude operation. Our standard air insulated units (32 KV and below) are operable up to approximately 2,500 feet. Check factory (or technical handbook) for voltage derating which is necessary to provide equivalent reliability and life at higher altitudes.

OPTIONAL EQUIPMENT

The following accessory items can be provided as optional equipment. Please contact factory for details.

RIPPLE ATTENUATORS Auxiliary filter sections to reduce ripple by a factor of 1/10 or 1/100 of rated ripple at rated voltage and current.

LINE VOLTAGE REGULATORS Line voltage regulators can be provided to maintain output constant to $\pm 1.5\%$ or $\pm .25\%$ for line voltage variations from 95-130 volts (or 190-260 volts).

CASTERS Caster trucks can be provided for ease in moving High Voltage Assemblies, Control Assemblies or the complete power supply. Casters are always furnished with Air Cabinets, 42" high and above.

REMOTE HIGH VOLTAGE POLARITY REVERSING SWITCH A panel operated switch controls polarity reversing in HV assembly for rapid and frequent changes.

CABINETS Complete equipment cabinets can be provided for two section units when it is desirable to have these assembled into one housing.

V.

OPERATING INSTRUCTIONS

A. PRELIMINARY SETTINGS

1. Set COARSE VOLTAGE CONTROL and VERNIER VOLTAGE CONTROL to zero.
2. Set the polarity selector switch on the control panel to correspond to the polarity setting made inside the high voltage assembly.
3. Set KV range and mA range selector switches to HIGH.

B. CIRCUIT BREAKERS AND TROUBLE LIGHTS

1. Set the MAIN CIRCUIT BREAKERS to the ON position. The MAIN CB OPEN pilot light will turn off.
2. Set CONTROL CIRCUIT BREAKER to the ON position. The CONTROL CB OPEN pilot light will turn off.
3. The pilot light labelled INTERLOCK OPEN will light if any external connections have not been closed. To proceed, all interlocks must be closed and the INTERLOCK OPEN light must be off. Interlock connections are made to TB1 on the chassis rear.
4. If the HV ACCESS OPEN pilot light is illuminated, check to see whether the access plate on the tank lid is open. It is impossible to proceed unless the HV access plate is closed and the HV ACCESS OPEN light is off.
5. Set the primary circuit breaker to the ON position. The PRIMARY CB OPEN pilot light will turn off.
6. When all interlocks are closed, the green HIGH VOLTAGE READY light will illuminate.

C. HIGH VOLTAGE ON

Press the black HIGH VOLTAGE ON pushbutton. The primary contactor inside the control section will pull in and lock in, and the red HIGH VOLTAGE ON pilot light will light. The green READY light will turn off.

NOTE

IF EITHER THE COARSE VOLTAGE CONTROL OR VERNIER VOLTAGE CONTROL IS NOT SET TO ZERO, THE SET CONTROL TO ZERO PILOT LIGHT WILL LIGHT WHEN THE HIGH VOLTAGE ON PUSHBUTTON IS DEPRESSED. THIS SIGNALS THE OPERATOR TO SET BOTH VOLTAGE CONTROLS TO ZERO. THE RED HIGH VOLTAGE ON LIGHT WILL NOT ILLUMINATE UNTIL ALL TROUBLE CONDITIONS ARE CLEARED.

D. OUTPUT VOLTAGE ADJUST

To RAISE output voltage, turn the COARSE VOLTAGE CONTROL or VERNIER VOLTAGE CONTROL clockwise. To LOWER output voltage turn either voltage control counterclockwise.

E. METER RANGES

Choose the required meter ranges. The selector switch coding is clear when compared to the scale markings on the meter dial face.

F. SURGE ON

When the SURGE ON (S4) and HV ON (S2) pushbuttons are pressed, the power supply will surge on. The high voltage will turn on although voltage controls are not at zero because interlock switches (S8) and (S9) are bypassed.

G. OVERLOAD AND OVERVOLTAGE

1. Adjust the overload and overvoltage settings by means of the small peg on the meter body. Always use the right peg. The left peg is a lower limit adjust and is not internally connected. Adjust the overload or overvoltage trip point by setting the upper limit red pointer to the desired trip voltage or trip current level.

CAUTION

**SWITCHING FROM RANGE
TO RANGE SHIFTS
THE TRIP POINT.**

2. An overload or overvoltage condition will activate a relay train which simultaneously disables primary power and prevents further operation of the equipment until the red HV OFF/RESET pushbutton is pressed.
 - a. In the event of an overvoltage, the blue OVERVOLT light will illuminate until the RESET button is pressed.
 - b. In the event of an overload, the yellow OVERLOAD light will illuminate until the RESET button is pressed.

NOTE

**A DC HOLDING CIRCUIT IS
EMPLOYED. TO RESET, HOLD
THE RESET PUSHBUTTON IN FOR
APPROXIMATELY ONE-HALF SECOND.**

H. RUN-UP PROCEDURE

Oil-immersed units require a program for run-up. This power supply has been tested at maximum-rated full load DC voltage with rated current prior to shipment. As with all oil-insulated high voltage power supplies, however, it is not possible to run the unit up to maximum voltage immediately after filling it with oil. At this time, air bubbles present a severe problem, making the equipment susceptible to permanent damage. Therefore, a careful run-up procedure is necessary.

The output voltage must be raised slowly to rated condition. Allow at least 24 hours for run-up. Equipment may be aged overnight to reduce the amount of work time lost.

The following schedule is recommended as a minimum when the power supply is to be energized for the first time, or whenever the oil has been changed.

RUN-UP

<u>OUTPUT VOLTAGE</u>	<u>HOURS OF OPERATION</u>
(% rated)	
40%	3
50%	1
60%	OVERNIGHT (12 HRS. APPROX.)
70%	1
80%	1
85%	1
90%	2
95%	2
100%	2

Aging is usually done at no load, in order to ensure that the power supply is working satisfactorily. However, the power supply may be used to furnish load during this run-up.

VI. THEORY OF OPERATION: CONTROL ASSEMBLY

A. NEON LIGHTS

When the circuit-breaker, interlock, or SET CONTROLS TO ZERO neon indicators light, they act as high impedances (in effect, open circuits) and as fault indicators. Series and shunt resistors provide current limiting and return paths.

B. HIGH VOLTAGE ON HOLDING CIRCUIT

When output voltage controls T1 and T2 are at zero and HV ON pushbutton S2 is pressed, contact 1A of contactor K1 is momentarily bypassed. K1 therefore pulls up and locks in by means of contact 1A. The HV OFF/RESET pushbutton interrupts contactor K1 coil power and disables primary power. Contacts 1C and 1D energize autotransformer input, which in turn controls HV input.

C. OVERLOAD AND OVERVOLTAGE

KV and mA meters M1, M2 are meter relay devices (Simpson Electric Model 29XA or equivalent).

When the overvoltage trip point is reached, the kilovoltmeter relay contacts close and energize auxiliary control holding relay K2, which is locked in when contact 2C closes. Contact 2B opens, disabling contactor K1 and the primary of the high voltage transformer. The blue OVERVOLT pilot light will illuminate.

When the overcurrent trip point is reached, the mA meter relay contacts close, energizing auxiliary control holding relay K3, which is locked in when contact 3C closes. Contact 3B opens, disabling contactor K1 and the primary of the high voltage transformer. The yellow OVERLOAD pilot light will illuminate.

To reset, depress the HV OFF/RESET pushbutton.

D. OVERLOAD BYPASS

When the OVERLOAD BYPASS pushbutton S3 is pressed, the unit can be operated in an overloaded condition. The contacts of mA relay M2 are bridged, and operation is as described in (C) except that primary power is maintained because contactor K3 is open. Because contact 3C is also kept open, the meter relay circuit cannot latch and contact 3B is bypassed. The OVERLOAD light will be on during overload bypass operation. The main and primary circuit breakers act as protective devices during overload bypass.

E. VERNIER VOLTAGE CONTROL

Autotransformer T2 feeds a signal to the primary of stepdown transformer T3. The output of T3 is fed into the primary of the high voltage transformer, series-aiding. This signal is approximately 2% of line voltage for full rotation of T2.

VI.**COMPONENT FUNCTIONS: HV ASSEMBLY****A. HIGH VOLTAGE TRANSFORMER (T101)**

This transformer is provided with primary taps to allow optimum setting for a given application. The wiring diagram gives connection details.

NOTE

**WE HAVE STANDARDIZED
PRIMARY CONNECTIONS
AS FOLLOWS:**

TERMINAL "1"	Start
TERMINAL "2"	5% up from start
TERMINAL "3"	Rated input terminal HIGHEST OUTPUT VOLTAGE WITH INPUT CONNECTED TO 2 AND 3
TERMINALS "4", "5", "6", etc.	10% adjustment taps

B. SPARK GAPS (E101-104)

The spark gaps have been furnished with covers to eliminate a potential dust hazard. These covers should always be replaced. The gaps have been factory-set to approximately .010 inches and protect the low voltage leads against high voltage surge damage. The gap will fire at approximately 900 volts peak. Varistors and secondary surge arrestors, which are designed to withstand higher voltage and current surges, are used in high voltage and power designs.

C. CAPACITORS (C101, C102)

The filter capacitors have been selected to withstand the no-load voltages encountered. Continuous no-load operation is not recommended, because this will affect the life of the capacitors. Dividers and bleeders (R104, R105) are provided where needed.

D. SERIES RESISTOR (R101)

The series resistor limits the discharge current in the event of load short circuit or sparkover. This device protects the load from uncontrolled current pulses and helps to eliminate steep transients within the power supply itself. The series resistor is designed to withstand the steady state power continuously and the voltage and current transients under short circuit. Consult UVC engineering before eliminating this resistor, as is necessary for pulsed loads.

E. HIGH VOLTAGE SAFETY GROUNDING SWITCH RESISTOR (R102)

This resistor limits the discharge current in the grounding switch contacts (H101, H102). The contacts are thereby protected from pitting and deterioration. In oil-immersed units this resistor serves the added function of keeping arcing to a minimum.

F. KILOVOLT METER MULTIPLIER RESISTOR (R103)

This resistor serves to increase the voltage range of the meter. The resistor is located in the high voltage assembly rather than in the meter case.

F. HIGH VOLTAGE CIRCUITS

A Full-Wave Voltage Doubler is used in this power supply.

Polarity is reversible. Reversing is achieved by changing the sense of the connections made to the high voltage rectifiers.

**VIII. DRAWINGS
SPECIFICATIONS
REPLACEMENT BILL OF MATERIAL**

Included in this section are the following:

A. BLOCK DIAGRAM:

This aids in the comprehension of circuit operation.

B. CONTROL WIRING DIAGRAM:

This gives a detailed point-to-point wiring scheme of the control assembly (panel, chassis, cabinet, etc.)

C. HIGH VOLTAGE ASSEMBLY WIRING DIAGRAM:

This gives a detailed point-to-point wiring scheme of the high voltage assembly.

D. REPLACEMENT BILL OF MATERIAL

DRAWING LIST

CONTROL WIRING	D-6-2-1525
HIGH VOLTAGE WIRING	B-6-1-1458
PCBD METER CARD	C-3-1891-38AF
SCHEMATIC	B-6-1891-38AF

Tabulated Specifications for UVC Model: BAL-130-28-T

- 1.0 Input Voltage: 208/230 Volts, 60Hz., 1 phase, 5KVA approx. WYE Source required.
- 2.0 Output Voltage: 0-130 Kilovolts DC.
- 3.0 Output Current: 28 Milliamperes DC.
- 4.0 Polarity: Reversible
- 5.0 Ripple: 2% rms at 130KVDC and 28MADC
- 6.0 Regulation: Load: 20% from no load to full load of 28MADC at 130KVDC.
- 7.0 Regulation: Line: OUTPUT VARIES DIRECTLY WITH LINE
- 8.0 Environmental Specifications: (Design Intent):
 - 8.1 Ambient temperature operating 35°C.
Ambient temperature storage 60°C.
 - 8.2 Humidity: 100%
 - 8.3 Shock and vibration: Normal transcontinental shipment
 - 8.4 Life expectancy: 10,000 hrs. (estimated)
 - 8.5 Altitude: 2500 ft.
- 9.0 Mechanical: The equipment is built in two assemblies:
 - 9.1 Control Assembly:
 - 9.1.1 Size: 22" W x 15" D x 16 1/2" H, approx.
 - 9.1.2 Weight: 75 lbs. approx.
 - 9.1.3 Color: UVC Gray, High Gloss
 - 9.2 High Voltage Assembly:
 - 9.2.1 Size: 24" O.D. x 36" H.
 - 9.2.2 Weight: 250 less oil
 - 9.2.3 Weight: 650 with 50 gals. oil
 - 9.2.4 Color: UVC Gray, High Gloss
- 10.0 Meters:
 - 10.1 Output Kilovoltmeter: 0-15/60/150 KVDC, +3% FS, 4-1/2" bakelite, meter relay
 - 10.2 Output Milliammeter: 0-3/10/30 Milliamperes DC, +3% FS, 4-1/2" bakelite, meter relay.

- 11.0 Safety and Protective Features:
- 11.1 Main Circuit Breaker
 - 11.2 Control Circuit Breaker
 - 11.3 Primary Circuit Breaker
 - 11.4 Overload Adjust (integral with milliammeter
100 m-sec. response, approx.)
 - 11.5 Overvoltage Adjust (integral with
Kilovoltmeter)
 - 11.6 External Interlock
 - 11.7 Zero Start Interlock
 - 11.8 Shorting Solenoid
- 12.0 Controls:
- 12.1 High Voltage Off, Reset Pushbutton
 - 12.2 High Voltage On Pushbutton
 - 12.3 Coarse Voltage Control
 - 12.4 Polarity (meter selector switch only)
 - 12.5 Vernier Voltage Control
 - 12.6 Milliammeter meter range selector switch
(3 range)
 - 12.7 Surge On (Bypass pushbutton)
 - 12.8 Kilovoltmeter meter range selector switch
(3 range)
 - 12.9 Overload Bypass pushbutton
- 13.0 Indicator Lights: (NEON except where otherwise indicated):
- 13.1 Main CB Open
 - 13.2 Control CB Open
 - 13.3 Interlock Open
 - 13.4 HV Access Open
 - 13.5 Set Controls to Zero
 - 13.6 Primary CB Open
 - 13.7 Overvoltage (incandescent - blue)
 - 13.8 Overload (incandescent - yellow)
 - 13.9 High Voltage Ready (incandescent - green)
 - 13.10 High Voltage On (incandescent - red)
- 14.0 Connections:
- 14.1 Input: 3 position terminal board, one
position ground
 - 14.2 Output Cable: RG 8/U 15FT
 - 14.3 Ground: Threaded stud, on chassis rear.
 - 14.4 External Interlock: Two position terminal
board on chassis rear.
 - 14.5 H.V. Access Interlock (on lucite rear panel)
 - 14.6 Interconnecting cable: 20FT

REPLACEMENT BILLS OF MATERIAL FOR: BAL-130-28-T

0 BAL-130-28-T LABTROL POWER SUPPLY

EA 8A

1..... 85-6-5-579
INTERCONNECT CABLE ASSY 1.000 EA 85
C-6-5-579 (REV-0)
(SEE SEP BOM)

1..... 8528551348
CONTROL ASSEMBLY 1.000 EA 85
D-2-855-1348
CONTROL WIRING D-6-2-1525 (REV-1)
BAL-130-28-T
(SEE SEP BOM)

1..... 8528551349
HIGH VOLTAGE ASSEMBLY 1.000 EA 85
D-2-855-1349
HIGH VOLTAGE WIRING B-6-1-1458 (REV-1)
BAL-130-28-T
(SEE SEP BOM)

0 8528551348 CONTROL ASSEMBLY EA 85
 D-2-855-1348
 CONTROL WIRING D-6-2-1525 (REV-1)
 BAL-130-28-T
 Notes: CONTROL WIRING D-6-2-1525
 CONTROL ASSY D-2-855-1348

..... 06100022			
SLEEVING EXPANDO 1-1/2	50.000 FT 06		XV-1
BLACK			
..... 12060099			
CAP MYLAR .01 UF 600V	2.000 EA 12		C-1-2
..... 14070013			
KNOB PANEL PROD 70-3-2	2.000 EA 14		XE-3,4
0.72 DIA			
(FORMERLY RAYTHEON)			
..... 14070015			
KNOB PANEL PROD 90-3-2	1.000 EA 14		XE-5
1 INCH DIA			
(WAS: RAYTHEON)			
..... 16400008			
HANDLE 10967-A-1032-2	2.000 EA 16		H-1,2
ANATOM 10967-A-1032-2			
SUB FOR JUPITER 6672			
VENALINE GV215-20			
.... 17010013			
LAMP INCANDESCENT 120MB	4.000 EA 17		I-7-10
..... 853189138AF			
PCBD METER & INDICATOR BD	1.000 EA 85		PC-1
C-3-1891-38AF (REV-0)			
B-6-1891-38AF (REV-1)			
(SEE SEP BOM)			

CONTROL ASSEMBLY

EA 85

D-2-855-1348

CONTROL WIRING D-6-2-1525 (REV-1)

BAL-130-28-T

..... 17020005			
LAMP NEON NE-51H B2A	6.000 EA 17		I-1-6
GLASS ONLY			
..... 18010049			
CONN MS 3102A-28-2S	1.000 EA 18		J-1
ANPHENOL			
..... 19060355			
CONTACTOR ABB BN25C-1	1.000 EA 19		K-1
..... 19070122			
AUX CONTACT ABB CA7-01	1.000 EA 19		XK-1
..... 21020011			
METER 3324 AIXA 0-50 UA	1.000 EA 21		M-1
SIMPSON SINGLE SET POINT, KE POINTER CAL FOR ALUM PANEL			
DIAL TO READ: 0-15/60/150 KV W/RED LINE @ 130 KVDC			
..... 21020013			
METER 3324 AIXA 0-500 UA	1.000 EA 21		M-2
SIMPSON 0-500 MICROAMP MOVEMENT			
SINGLE SET POINT			
DIAL TO READ: 0-3/10/30 MA W/RED LINE @ 28 MADC			
..... 24040271			
RES CC 62K 2W 5%	1.000 EA 24		R-22
ALLEN BRADLEY HB 6235			
..... 25020020			
ELECTRO SWITCH PA-2002	2.000 EA 25		S-6,7
..... 25020029			
SWITCH PA-2020	1.000 EA 25		S-5
CENTRALAB			
..... 25050015			
SWITCH TSCHUDIN 500108	2.000 EA 25		S-2,4
(OLD: UNIMAX TH31-121)			

CONTROL ASSEMBLY

EA 85

D-2-855-1348

CONTROL WIRING D-6-2-1525 (REV-1)

BAL-130-28-T

..... 25050100			
SWITCH EAO 31-124	1.000 EA 25		S-1
PUSHBUTTON			
..... 25050101			
SWITCH EAO 31-122	1.000 EA 25		S-3
PUSHBUTTON			
..... 25080001			
SWITCH BZ-2-RW80	1.000 EA 25		S-8
MICROSWITCH			
..... 25080030			
SWITCH 311SM1-T	1.000 EA 25		S-9
MICROSWITCH			
..... 26040100			
XFMR TRIAD H-5MG	1.000 EA 26		T-5
ISOLATION 230/115			
250VA			
TRIAD			
..... 26080014			
XFMR SUPERIOR 10C	1.000 EA 26		T-2
..... 26080024			
XFMR SUPERIOR 136BU	2.000 EA 26		T-1
POWERSTAT			
..... 30040001			
LAMPHOLDER 95-0410-09-301	10.000 EA 30		XI-1-10
DIALIGHT			
WAS: DRAKE 5200-222-607			
..... 30160068			
LENS 135-1471 RED	1.000 EA 30		XI-10
DIALIGHT			
..... 30160069			

CONTROL ASSEMBLY	EA 85	
D-2-855-1348		
CONTROL WIRING D-6-2-1525 (REV-1)		
BAL-130-28-T		
LENS 135-1472 GREEN DIALIGHT	1.000 EA 30	XI-9
... 30160124 LENS 135-1437 CLEAR DIALIGHT	6.000 EA 30	XI-1-6
... 30160162 LENS 135-1474 BLUE DIALIGHT	1.000 EA 30	XI-7
... 30160163 LENS 135-1473 AMBER DIALIGHT	1.000 EA 30	XI-8
... 30160190 LENS EAO 01-901.5 GREEN	1.000 EA 30	XS-2
... 30160191 LENS EAO 01-901.2 RED	1.000 EA 30	XS-1
.... 30160197 LENS EAO 01-901.4 YELLOW	2.000 EA 30	XS-3,4
.... 31010004 CB AM1-A3-A-3-2 3 AMP 1 POLE 250V CURVE 2 HEINEMANN	1.000 EA 31	CB-2
.... 31010021 CB 30 AMP AM1-A2-A-30-2 CURVE 2 HEINEMANN	1.000 EA 31	CB-3
.... 31020005 CB 30 AMP AM2-A3-A-30-2 CURVE 2 HEINEMANN	1.000 EA 31	CB-1
.... 33050003 TERM BD CINCH 4-142	1.000 EA 33	TB-6

CONTROL ASSEMBLY
D-2-855-1348
CONTROL WIRING D-6-2-1525 (REV-1)
BAL-130-28-T

EA 85

..... 33060003 MARKER STRIP MS-4-142 CINCH	1.000 EA 33	MS-6
..... 33070002 TERM BD CINCH 3-150	1.000 EA 33	TB-2A
..... 33080002 MARKER STRIP MS-3-150 CINCH	1.000 EA 33	MS-2A
..... 33150001 TERM BD CINCH 2-141Y	1.000 EA 33	TB-1A
..... 33160001 MARKER STRIP MS-2-141Y CINCH	1.000 EA 33	MS-1A
..... 33220005 TERM BD CINCH 2010	1.000 EA 33	TB-3
..... 34030027 WIRE HOOK-UP #10 BLACK UL1028	75.000 FT 34	W-1
..... 34030079 WIRE #16 BLACK UL1015 STRANDED 600V	125.000 FT 34	W-1
..... 40040116 VARISTOR V230LA20A	2.000 EA 40	E-1,2
..... 85-3-13-166 UVC TRANSFORMER UVC 3-13-166 CORE: AA-14 PLATE: 2-188-2 (SEE SEP BOM)	1.000 EA 85	T-3

0 8528551349 HIGH VOLTAGE ASSEMBLY

EA 85

D-2-855-1349

HIGH VOLTAGE WIRING B-6-1-145B (REV-1)

BAL-130-28-T

Notes: HIGH VOLTAGE WIRING B-6-1-145B

HIGH VOLTAGE ASSEMBLY D-2-855-1349

.....	10180018 85 GALLON DRUM (W/ COVER AND BAND) + (DRUM COVER PIERCING D-2-2240-186)	1.000 EA 10	A-101
.....	12070014 CAP POLYPROP 2 UF 400V SPRAGUE 735P205X9400L	1.000 EA 12	C-103
.....	16020037 EYE NUT 5/8-11 STEEL ZINC F.W. WEBB 710-0106	4.000 EA 16	A-104
.....	16020048 NUT T&B 142 3/4 IN USED W/2534 CONNECTORS	1.000 EA 16	E-105
.....	16310037 BUSHING T&B 2534 LIQUID TIGHT	1.000 EA 16	E-105
.....	16440008 SEALING RING T&B 5263	1.000 EA 16	E-105
.....	16470001 SPARK PLUG COVER EP-10 YELLOW SLIP ON	4.000 EA 16	H-103
.....	18010048 CONN MS 3102A-28-2P AMPHENOL	1.000 EA 18	J-101
.....	18030022 JACK BAKANA SMITH 101	5.000 EA 18	J-102-105 P-106

HIGH VOLTAGE ASSEMBLY
D-2-855-1349
HIGH VOLTAGE WIRING B-6-1-1458 (REV-1)
BAL-130-28-T

EA 85

.... 18050010			
JACK BANANA BIRNBACH 394	1.000 EA 18	J-107	
LARGE, LONG			
.... 22030003			
BANANA PLUG SMITH 100	4.000 EA 22	P-102-105	
.... 23010251			
RECT STICK DO.22/200X41	4.000 EA 23	CR-101-102	
TELEFUNKEN			
.... 24090023			
RES WW 5K 50W 10%	5.000 EA 24	R-101	
CLAROSTAT VP50K			
(5 IN SERIES)			
... 24260017			
RES HV 40KV 3M 10W 15%	2.000 EA 24	R-102	
BFW 3 MEG OHM			
CARBON FILM			
(IN SERIES)			
... 24360030			
RES HV 80KV 95M 20W 2%	3.000 EA 24	R-103	
BP-20 CARBON FILM MATCHED PAIR PRECISION			
(3 PAIRS)			
... 24740001			
RES BMW DALE 1G 5%	14.000 EA 24	R-104,105	
... 25080018			
SWITCH MICROSWITCH 2PL4	1.000 EA 25	S-101	
... 34040012			
CABLE COAX RG 220/U	20.000 FT 34	W-101	
REPLACES RG 19/U			
... 40040050			
VARISTOR GE V36ZA80	2.000 EA 40	E-103,104	

HIGH VOLTAGE ASSEMBLY
 D-2-855-1349
 HIGH VOLTAGE WIRING B-6-1-1458 (REV-1)
 BAL-130-28-T

EA 85

GE

1.....	40040116 VARISTOR V230LA20A	2.000 EA 40	E-101,102
1.....	85-3-10-B1 UVC TRANSFORMER B-3-10-B1 (SEE SEP BOM)	1.000 EA 85	T-101
1.....	85-MW-13 UVC CAP .12 UF 12KV 2-13/16 L x 2-1/4 W x 1-1/2 THICK (ALL +/- 1/16) (2 IN PARALLEL / 7 IN SERIES) PER LEG	28.000 EA 85	C-101,102
1.....	853183124A SOLENOID SWITCH ASSEMBLY UVC D-3-1831-24A (SEE SEP BOM)	1.000 EA 85	K-101
1.....	854190687F CABLEWELL ASSEMBLY C-4-1906-87F (SEE SEP BOM)	1.000 EA 85	

SHOW.PS

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Sys hp817 Acct en:UVC.MAIN Page 1

Single-Level Bills of Material - Effective as of 09-09-94

Level/Item

Description

Qty/Assy UM IT Bal Scrp MPBTS Rv LT RTG ECO

ECO Note Reference

Ndr % PHNPC Lv Off Seq Number

Date Reference Designator

0 853189138AF PCBD METER & INDICATOR BD
 C-3-1891-38AF (REV-0)
 B-6-1891-38AF (REV-1)

EA 85

M A 1

Notes: ARTWORK C-2-1891-38
 ASSEMBLY C-3-1891-38AF
 DRILLING C-4-1891-38
 ELECTRICAL C-6-1891-38AF

1.....	12010043 CAP ELEC 500 UF 25V SPRAGUE TVA 1209	1.000 EA 12	P A	C-4
1.....	12060057 CAP MYLAR .25 UF 200V SPRAGUE 2PS-P25	1.000 EA 12	P A	C-3
1.....	22070009 CONN 00-6007-044-450-012 ELCO 44 PIN SUB FOR VECTOR #R-644 SUB FOR AMPHENOL #225-22221-401-117	1.000 EA 22	P A	J-1
1.....	23010003 SILICON DIODE EDAL BSM5 1 KV, 1 AMP 10 CYCLE SURGE: 60A	8.000 EA 23	P A	CR-1,2
1.....	24030289 RES CC 33K 1W 5% AB #GB3335	10.000 EA 24	P A	R-20,21 R-23,24 R-25,26 R-27,28 R-29,30
1.....	24050020 RES WW 250 5W	1.000 EA 24	P A	R-19
1.....	24440049 RES PRC WW 34 .5W 1% PRC/SX186	1.000 EA 24	P A	R-16
1.....	24440070 RES PRC WW 105 .5W 1%	1.000 EA 24	P A	R-17

SHOW.PS

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UNIVERSAL VOLTRONICS CORP

Sys hp817 Acct eh:UVC.MAIN Page 2

Single-Level Bills of Material - Effective as of 09-09-94

Level/Item	Description	Qty/Assy	UM	IT	Bal	Scrp	MPBTS	Rv	LT	RTG	ECO	ECO	Note	Reference
		NBR	%	PHNPC	Lv	Off	Seq	Number	Date	Reference	Designator			
0	853189138AF PCBD METER & INDICATOR BD C-3-1891-38AF (REV-0) B-6-1891-38AF (REV-1) PRC/SX186	EA 85												
1.....	24440089 RES PRC WW 400 .5W 1% PRC/SX186	1.000 EA 24												R-18
1.....	24440107 RES PRC WW 1.6K .5W 1% PRC/SX186	1.000 EA 24												R-15
1.....	24440133 RES PRC WW 5.56K .5W 1% PRC/SX186	1.000 EA 24												R-13
1.....	24440161 RES PRC WW 16.7K .5W 1% PRC/SX186	1.000 EA 24												R-14
1.....	24440187 RES PRC WW 40K .5W 1% PRC/SX186	1.000 EA 24												R-12
.....	24460006 RES PRC WW 1M .85W 1% PRC/SX1812	1.000 EA 24												R-11
1.....	24630019 TRIMPOT 68WR 20K .5W 10% BECKMAN CERMET ELEMENT MULTI TURN, PC PIN	1.000 EA 24										009064 09-09-94		R-31
1.....	24630059 TRIMPOT 68WR 500 .5W 10% BECKMAN CERMET ELEMENT MULTI TURN, PC PIN	1.000 EA 24												R-32
1.....	27110038 PC BD BLANK 1891-38	1.000 EA 27												PC-1
1.....	40040076 VARISTOR GE V68ZA10	1.000 EA 40												V-1